The American Midland Naturalist

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The American Midland Naturalist

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Vol. XIV. SEPTEMBER, 1933 No. 5

CAVE LIFE OF KENTUCKY

MAINLY IN THE MAMMOTH CAVE REGION

VERNON BAILEY

With chapters on

THE BIRDS, by Florence Merriam Bailey

and on

THE INVERTEBRATES, by Leonard Giovannoli

Prepared in the Bureau of Biological Survey, U. S. Department of Agriculture, Paul G. Redington, Chief, in cooperation with the Kentucky State Geological Survey, Willard R. Jillson, Director.

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LETTER OF TRANSMITTAL

United States Department of Agriculture,
Bureau of Biological Survey,
Washington, D. C., May 25, 1933.

Dear Sir: The accompanying manuscript "Cave Life of Kentucky, Mainly in the Mammoth Cave Region" was prepared in the U. S. Biological Survey in 1930, at the request of the Kentucky State Geological Survey. It was the intention of that organization to publish the report as one of its bulletins, but the subsequent abolishing of the survey makes that disposition impossible. It is now offered to the American Midland Naturalist for publication in such form as will admit of the widest possible distribution to the interested public.

The chapter on invertebrates of the caves was prepared by Leonard Giovannoli, then of the Kentucky Geological Survey, who had done much of the field work. The chapter on birds was written by Mrs. Florence Merriam Bailey in cooperation with the U. S. Biological Survey. All of the remaining chapters are by Vernon Bailey of this bureau, and all except the one on fishes are on subjects of special concern to the Biological Survey. The chapter on the fishes was reviewed by Barton A. Bean, then assistant curator of fishes in the U. S. National Museum, and he is responsible for the names used.

The manuscript as transmitted comprises 289 pages and 90 illustrations, and constitutes a rather comprehensive report on the general natural history of the Mammoth Cave region, now under consideration as a National Park, with special reference to the caves themselves.

Respectfully yours,

Paul G. Redington,

Chief, Biological Survey.

Editor of the American Midland Naturalist,
Notre Dame, Indiana.

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ACKNOWLEDGMENTS

The original request for a report upon the Kentucky Cave life came through Willard Rouse Jillson, Director of the Kentucky Geological Survey, who has been most helpful in suggestions and cooperation throughout the field work and the preparation of the report.

Leonard Giovannoli, employed by the Kentucky Geological Survey to do the necessary field collecting in addition to what has been done by the Biological Survey, was so successful in getting specimens of the various forms of animal life in and about the caves and in securing interesting notes on habits and life history that his contributions toward the success of the report have been most important, especially in regard to the invertebrates, on which he has also prepared the manuscript.

The preparation of the bird report from her own field notes and those of Giovannoli and others in the Mammoth Cave region and such published material as is available, has been the voluntary contribution of Florence Merriam Bailey.

The identification of specimens collected has been mainly by specialists in the U. S. National Museum to whom much credit for the value of the report is due. The bats were determined by Gerrit Smith Miller, Jr., the mole and shrew by Hartley Harrad Thompson Jackson, the chipmunk by Arthur Holmes Howell. The reptiles and amphibians were named by Leonhard Stejneger and Miss Doris Cochran, the fishes by Barton Appler Bean, the mollusks by Paul Bartsch, the crustaceans by Waldo La Salle Schmitt, the spiders by Clarence Raymond Shoemaker, the mites and fleas by Henry Ellsworth Ewing, the springtails and bristletails by Harold Morrison, the crickets by Andrew Nelson Caudell, the flies by John Merton Aldrich, the moths and beetles by Lee L. Buchanan and W. S. Fisher, the flatworms by Libby Henrietta Hyman, of the University of Chicago, and the earthworms by Frank Smith.

For important suggestions and corrections we are indebted to Herbert Spencer Barber, of the Bureau of Entomology.

Photo by Willis T. Lee, Courtesy U. S. Geological Survey.

OLD ENTRANCE OF MAMMOTH CAVE

Fig. 1.—Looking out from the floor level at bottom of the upper tunnel at about the limits of green plant life. Note trace of old road. The smoky shrews were found under the slide rock near the wall on the right.

I.—INTRODUCTION

HISTORY AND PREHISTORY OF MAMMOTH CAVE

Mammoth Cave has long been the best known cave in North America, with a historic record of importance and interest as well as a prehistoric record as yet unread. In 1797 it was used as a landmark in land surveys and it may have been known at even an earlier date. When found in 1809 by a white hunter named Houchens it had long been the home of native peoples as well as of wild animals, for the hunter found it by tracing a wounded bear into its depths and it still shows the remains of camp fires and the accompanying refuse of people who inhabited its extensive galleries before white men came to settle that part of the country.

With credit to their intelligence and enterprise, the early settlers soon discovered that the floors of some of the first large rooms of the cave were covered with bat guano mixed with earth, salts, and other minerals rich in saltpeter, from which gunpowder could be manufactured. To these hunters and Indian fighters of our early frontier no other single substance could have been more useful or important. Even gold could not have won the country for us without the smoky, smelly old black powder that played such an important part in winning the West and holding the East. Our younger generations do not even know the look or smell of this vile, black powder, but in the early history of our country its possession by the whites gave supremacy to the few against the great number of natives, who were without knowledge of death-dealing explosives.

Soon Mammoth Cave became a busy center for the mining of saltpeter. The old vats where the rich earth was leached may still be seen, scattered along the sides of the cave for half a mile back from the entrance, and the old wooden pipes or logs bored out with two-inch augers and fitted end in end for carrying the spring water back to the vats, and another line through which the solution was pumped back to the evaporating tanks near the entrance are still sound and many of them are in place. Now the works that produced powder for

our early wars have been long abandoned. Better powders have been invented and our saltpeter supply now comes from coal, oil, or the air, or from the rich deposits of South America, and is used mainly for fertilizer.

Wheel tracks of the ox carts used in hauling in supplies and hauling out niter-laden earth, as well as the deep tracks of the oxen, still show plainly in the old road that runs back on the floor of the cave for half a mile, and the walls are heavily coated with carbon from the smoke of camp fires, lights, and torches used in the mining operations of those early days. Even farther back the walls were smoked from Indian fires, as shown by numerous beds of ashes and charcoal, charred embers, and cave torches found along the great hallways of the cave, where occasionally are found pieces of old straw sandals, moccasins, pottery, gourds, and other implements of primitive life.

Apparently no real study of the early human life of Mammoth Cave has been made nor of the still more evident human occupation of other caves, such as Old Salts Cave, Haunted Cave, Dixon Cave, and Long Cave of the general vicinity. These open refuges in the bowels of the earth, affording always shelter, comfortable temperatures, and safe retreats, were evidently occupied by the early races, and when fully explored by competent ethnologists may yet help to carry American history back through prehistoric ages.

Mammoth Cave is only one of a dozen or more caves of spectacular interest in the vicinity. There are said to be 500 known caves in Edmonson County and 4,000 sink holes (Eigenmann, p. 4). The Cave Region includes nearly half of the state of Kentucky. It is a region where the drainage is largely underground, through limestone formations that have been dissolved by the acid in surface water until the whole is tunneled by subterranean watercourses, large and small. Many of these tunnels have been blocked and broken by their fallen roofs, cut through by recent river valleys, left high and dry by elevated ridges, or hidden under the solid rocks of the plateau tops.

Each cave is different from all the others. Various types of rock are eroded and hollowed out according to mineral and

structural formation so that the galleries and rooms of the caves take on peculiar forms and proportions. Erosion and cleavage as well as deposition and crystallization have all contributed their art to strange architecture and fantastic formations. Slight variations in mineral content paint color schemes, often beautiful and artistic. Slight differences in temperature, humidity, and air currents modify the animal life of different caves, and even in different rooms in the same cave, and must be taken into consideration in the study of cave life.

To the superficial tourist, interested mainly in the elephant's head on the wall, George Washington's profile, the cooing doves, the devil's stairway, or fat man's misery, any cave will do, and the best known or most widely advertised are generally most visited. To those really interested in caves or in any part of the study of subterranean formations, history, or life, every cave is of interest and contributes to our total sum of knowledge.

In fact, many of the unknown or rarely visited caves will afford far greater interest for the study of geology, crystallography, and biology, than the famous caverns, with parties of tourists streaming through them night and day. Some of the caves advertise twenty-four hour service and take parties through at all hours of day or night. No wonder the cave crickets have to hunt for dark places.

Competition may have its value in many ways but in cave management it could be made most practical and useful in providing comfortable, attractive accommodations for the visiting public. Most important, however, is the giving out of reliable information and the employment of guides with some technical knowledge of cave formation and cave life.

ROADS AND RIVERS

Much of the future value of the Mammoth Cave region depends upon its being made easily available at all seasons, for it has a mild winter climate as well as a generally comfortable summer temperature. The Louisville and Nashville Railroad cuts through the heart of the cave country with a branch line running from Glasgow Junction to Mammoth Cave. The nearest station, Cave City, only 10 miles from Mammoth Cave and nearer to several of the other well-known caves, connects with

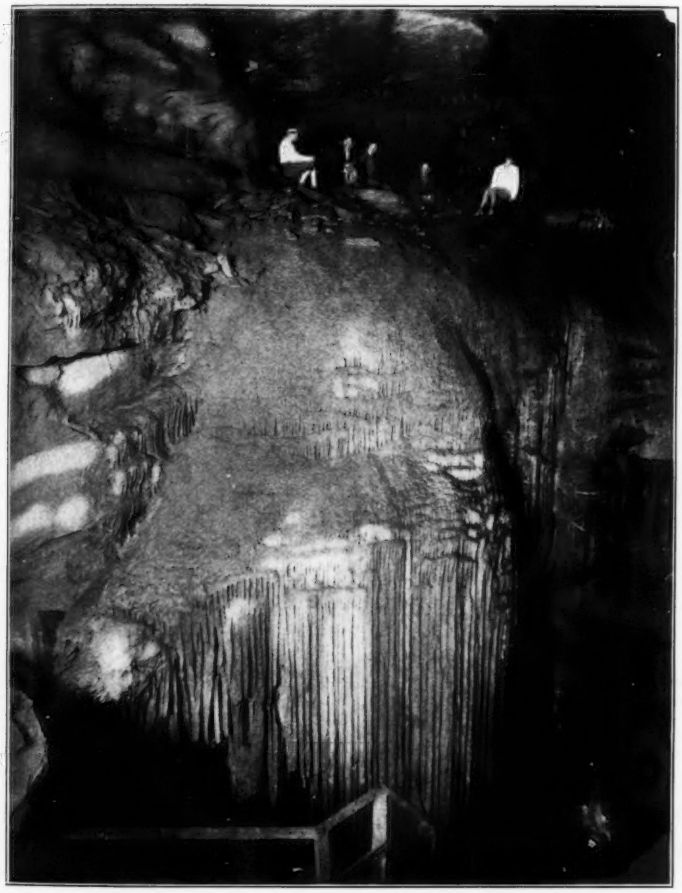


Photo by Willis T. Lee, Courtesy U. S. Geological Survey.

FROZEN NIAGARA

Fig. 2.—One of the spectacular formations in the New Entrance section of Mammoth Cave.

all of them by roads and bus or private transportation lines. In dry weather the dirt roads vary from good to fairly passable, but in stormy times they are far from satisfactory. In a rough country like this progress is slow and there are fewer satisfactory main lines than could be desired. Much of the general region is picturesque and very enticing to the motorist, camper, and hiker with leisure for exploring the woods, roads, and trails, and better roads are greatly to be desired.

Most of the cave visitors now come in automobiles and go direct to the hotels or inns at the larger caves, but there could be planned most interesting hiking trips by individuals or small parties arriving by train and bus, and visiting the unused and little known caves as well as those now open to the public. Local guides who know the country are easily found and extremely interesting trips can be made on foot over trails or wood roads through picturesque country.

There are numerous free or public camp grounds and many farmhouses or wayside cottages where comfortable quarters are open to motorists at reasonable prices and good hotels and inns are found at most of the villages and at some of the caves. In fact, the tourist travel brought by the caves affords an important industry to a large portion of the resident population, and the advantage of good service and courteous treatment of travelers is generally recognized.

To the canoeist or motor-boat lover, the rivers of the region offer a rich field for exploration, and one of the most fascinating trips by boat is along Green River through the cave region. At least half a dozen caves are to be found near the river and others at a little distance are known to local residents. The high cliffs and ledges along the river walls often show openings and caverns worthy of study and the general scenery is wild and picturesque in the extreme. Delightful camping spots are to be found along the shores and a leisurely trip of many days would well repay the canoe paddler or the light motor-boat traveler. Good fishing in most of the streams would appeal to some, and the general interest of wild life and vegetation along the quiet shores should appeal to all lovers of the out-of-doors.

The great blue heron that flaps on broad wings from the

sandbar just around the curve, the little green heron that skulks along the shady shore, the kingfisher that with shrill rattle springs from an overhead snag are ever-recurring features of a river trip, and as the silent canoe glides along still waters the heavy pounding or loud laugh of the pileated woodpecker may be heard from the wooded shores, while songs of cardinals, thrashers, mockingbirds, and Carolina wrens come from the trees and thickets along both banks. Turtles bask on the old logs and an occasional harmless water snake swims across the river in front of the boat. Big yellow-bellied fox squirrels are occasionally seen in the tree tops or shy woodchucks on the rocks above, but the days are gone when the white-tailed deer might be seen browsing along the steep slopes or the black bear ranging in the shadowy woods.

To the botanist and ecologist the river trip is especially rich in abundance and variety of plant life, from the occasional dense jungles of canes, "cane-brakes," on the islands or along the shores, the huge sycamores, tulip trees, and gums on the rich river bottoms, to the chestnut, oak, and hickory covered slopes and ridges leading back to the plateau country above. Cool shady hillsides that receive little sunlight carry many northern shrubs, flowering plants, ferns, and mosses, while the hot slopes bear more southern forms, including a few that characterize the Lower Austral Zone to the south. The bulk of the vegetation, however, belongs to the Upper Austral Zone, the middle zone of the eastern United States.

For the archaeologist and ethnologist there are rich fields of study in ancient cave dwelling and burial mounds of primitive people, but to the novice these records should remain as sacred and inviolate as the tombs of our own ancestors until such time as they can be given scientific study that their secrets may be fully revealed. The location and general character of such historic remains should be reported to the Secretary of the Smithsonian Institution at Washington, D. C.

The geology of the country is especially well illustrated along the river channels, where naked cliffs and steep slopes often rise two to four hundred feet in abrupt walls of exposed stratifications, dating back into millions of years of geological history.

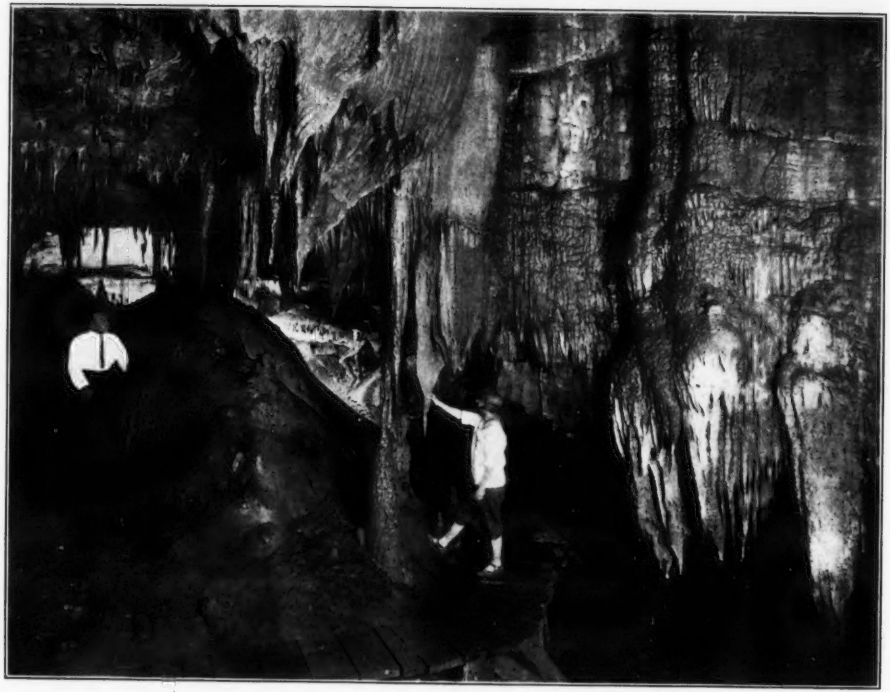


Photo by Willis T. Lee, Courtesy U. S. Geological Survey.

MOTHER'S SHAWL AND PYRAMID

Fig. 3.—In New Entrance section of Mammoth Cave.

RESEARCH AND EDUCATION

Many fields of scientific research into the secrets of cave life, involving problems in geology, biology, and archaeology, have all contributed to our steadily increasing sum of human knowledge, but in no case have they been exhausted or even more than well begun. Speaking only of the field of biology, which has perhaps lagged behind, we realize most keenly how much more there is to be done and hope that years of careful detailed study along many lines will yield as important and startling facts as have the patient investigations of the past. Such studies are never finished and we can add to them only step by step.

Little has been done in locating bones and skeletons of animal inhabitants of these caves, but it seems not too much to predict that discoveries will be made in some of the well-known or little-known caves of this region as important as have been made in other parts of Kentucky, Pennsylvania, Virginia, and Missouri. A peculiar type of cave with side chambers that have been dry for the long ages while used as wild animal lairs is well suited to preserve the bones of animals, whether inhabitants of the caves that have died and left their skeletons to become desiccated or petrified or the scattered bones of game animals brought in as food of carnivores or, in case of the owls, the disgorged pellets filled with bones. Such prehistoric deposits are not likely to be found by inexperienced excavators but in any case should not be disturbed until they can be carefully studied in situ. Only by such studies can the history of the caves be carried back into ancient times and connected with the native wild life of previous ages.

Fig. 3.—In New Entrance section of Mammoth Cave.

Birds are probably the best known and most appreciated group of native animal life in the cave region, but our studies have not been carried through the entire year, and a much more extensive list remains to be prepared and many additional habits and habit notes recorded for the benefit of future visitors who have only limited time in which to enjoy the varied interests of the region.

The study of fishes of underground waters, their relationships, adaptations, habits, and distribution, has shown one of the most fascinating steps in evolution, but it is based on a

few species from a few localities and much more extensive collecting must be done before our knowledge of the subject can be considered satisfactory. The few fishes of general distribution found in the caves bring up interesting problems as to how and why they got there, how long they can remain, and what their habits are in their outside habitat. The river fishes close to the caves are worthy of much more thorough study.

The reptile life of the region has little connection with caves or subterranean areas but is interesting as a local outside study and is rich in possibilities of discovery.

The amphibian life of the caves, however, is well worth more extensive study and should be based on thorough collections of specimens, especially salamanders, from as many different caves as possible as well as from all the intervening outside country. The caves are especially rich in species of these not well-studied vertebrates.

The invertebrate life of the caves, especially the crustaceans and insects, has been sporadically gathered from a few localities, but the number of species of many groups will be greatly increased by thorough and expert collecting in the well-known as well as the little-known caves of the region. The adaptations and life habits of the indigenous species of cave dwellers also provide subjects of fascinating study with possibilities of adding to our better understanding of evolution and other processes of the living world.

The educational possibilities of great national attractions like the Mammoth Cave and the many other caves around it are beginning to be appreciated. With thousands of people coming every year, often from far away, to see and enjoy a region of which they have heard, there is a large open-minded eager audience well deserving all the help that can be given in their quest for knowledge.

The vivid picture of geological processes, properly explained and understood, makes the first and probably most permanent impression and serves as a foundation for other and often more appealing interests in the native wild life. The importance of giving reliable information in the most effective manner is now engaging the minds of many of our leading educators in connection with the National Parks edu-

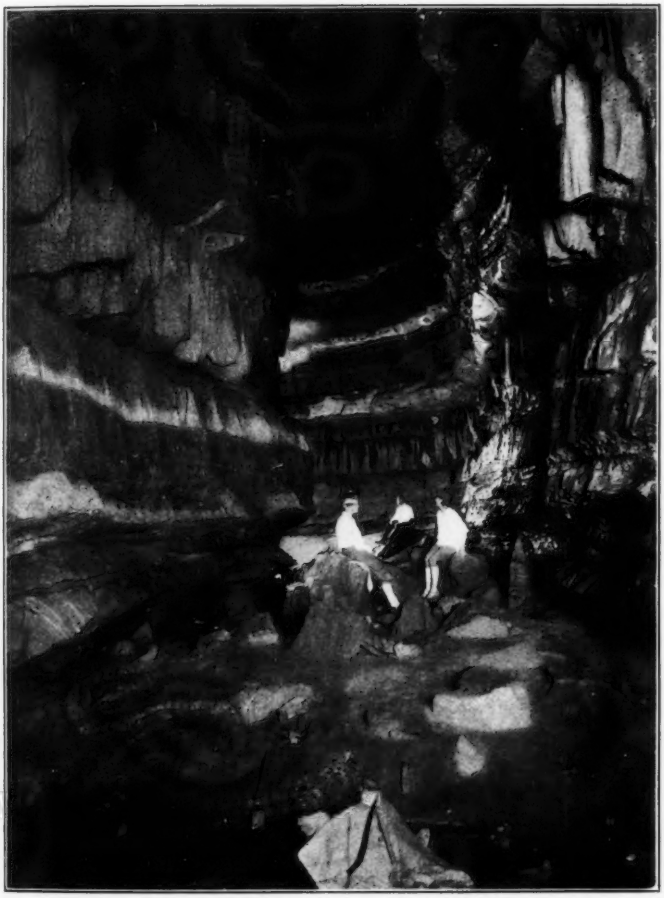


Photo by Willis T. Lee, Courtesy U. S. Geological Survey.

HOVEY'S CATHEDRAL

Fig. 4—In New Entrance of Mammoth Cave.

Photo by Eugene J. Hall.

THE BRIDAL CHAMBER AND ALTAR

Fig. 5—A typical room in Mammoth Cave with dry dusty floor and dry walls.

cational program, and this Cave Region affords an excellent opportunity for developing a better educational system along certain lines.

Park naturalists and park lecturers are now regularly employed to give out to the public the best information available through lectures, informal talks along the routes, local museums with fully labeled specimens, "nature trails," where each object of interest is labeled and explained, and by publications filled with reliable information. Lantern slides and moving pictures are being used to make the impressions more vivid and to economize the time of both lecturers and audiences.

Leading naturalists and educators of the country have combined to make this form of outdoor education comparable to the best post-graduate work of our colleges and universities, and some have even gone so far as to give it a higher rank in actual value to the public, in the advance of human knowledge and civilization, and in affording a fuller understanding of our place in the universe.

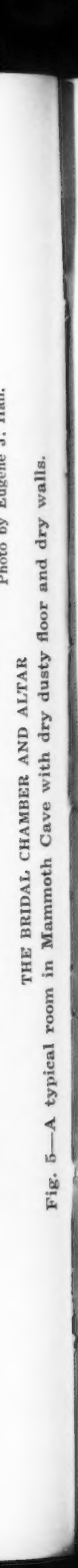


Photo by Eugene J. Hall.

THE BRIDAL CHAMBER AND ALTAR

Fig. 5—A typical room in Mammoth Cave with dry dusty floor and dry walls.

VEGETATION AND ECOLOGY

The Mammoth Cave Region is exceedingly rough and broken, with deeply eroded stream valleys, high narrow ridges, isolated buttes, and innumerable sink holes and sunken valleys where the roofs of caves have fallen in. The altitude above sea level varies from 500 feet along Green River to 900 feet on the higher ridges, and in many places the slopes are very steep and often cut into narrow gulches with rocky walls or cliff-like borders.

The drainage of the country, except for the rivers, is largely underground. There are no surface lakes but numerous small ponds fill the sink holes where rocks and earth have caved in and blocked the entrances to subterranean caverns or stream courses.

The region lies wholly within one life zone, the *Upper Austral*, or the zone of corn and tobacco, but it offers many of the interesting local problems of ecology in both animal and plant association. Geology, soil, erosion, slope exposure, moisture, aridity, vegetative cover, and human inter-

ference are some of the factors influencing the distribution and grouping of the present fauna and flora.

Originally the country was noted as mainly magnificent forest with its many so-called "prairies," or "barrens," open grass lands where herds of buffalo and elk roamed and fed on the rich grasses. These open areas were long ago brought under cultivation and most of the forest has been cut down to make room for farms, homes, and cities. Still much rough land, many steep slopes, and deep ravines remain where cultivation of the soil is not possible, and where timber is the best crop the land can produce. Such areas have been generally cut over several times since the country was settled, while the younger growth is being protected until such time as it becomes commercially valuable.

Some of the old trees with hollow trunks and boughs still serve as seed bearers of the forest and also as refuges for many of the forest birds and mammals. These old trees have real value and interest as factors in forest and wild life preservation and in adding beauty and picturesqueness to the woods. Many of the old chestnut trees are dead or dying, but nearly half of these valuable nut-bearers are still resisting the blight sufficiently to bear a partial crop of nuts. Oaks are generally the dominant element of the forest and the fact that some of the species bear a good crop of acorns almost every year has been and still is an important factor in the maintenance of the game mammals and birds. Other nut trees are abundant and important, as are the many fruit-bearing trees and shrubs of the forest.

The following list gives most of the conspicuous trees and shrubs and some of the commoner forms of low vegetation:

THE PRINCIPAL FOREST TREES*

Red Oak *(Quercus rubra)*, abundant.
Black Oak *(Quercus velutina)*, common.
Black Jack Oak *(Quercus marylandica)*, common.
Spanish Oak *(Quercus falcata)*, common.

* Plant names are mainly from Gray's New Manual of Botany, 1908 edition, with changes in common names to agree with Standardized Plant names of 1924.

White Oak *(Quercus alba)*, abundant.
Bur Oak *(Quercus macrocarpa)*, common.
Cow Oak *(Quercus michauxii)*, common.
Chestnut Oak *(Quercus muhlenbergii)*, common.
Chestnut *(Castanea dentata)*, abundant.
Chinquapin *(Castanea pumila)*, local, scarce.
Beech *(Fagus grandifolia)*, abundant.
Shagbark Hickory *(Hicoria ovata)*, common.
Shellbark Hickory *(Hicoria laciniosa)*, common.
Mockernut Hickory *(Hicoria alba)*, common.
Pignut Hickory *(Hicoria glabra)*, common.
Bitternut Hickory *(Hicoria cordiformis)*, common.
Black Walnut *(Juglans nigra)*, abundant.
Butternut *(Juglans cinerea)*, abundant.
Buckeye *(Aesculus glabra)*, common.
Basswood *(Tilia heterophylla)*, common.
Sugar Maple *(Acer saccharum)*, common.
Black Maple *(Acer nigrum)*, common.
Silver Maple *(Acer saccharinum)*, common.
Red Maple, Soft Maple *(Acer rubrum)*, common.
Boxelder *(Acer negundo)*, common.
River Birch *(Betula nigra)*, common along river.
White Ash *(Fraxinus americana)*, abundant.
Blue Ash *(Fraxinus quadrangulata)*, common.
Green Ash *(Fraxinus lanceolata)*, common.
Red Ash *(Fraxinus pennsylvanica?)*, common.
Water Ash *(Ptelea trifoliata)*, common.
White Elm *(Ulmus americana)*, abundant.
Rock Elm *(Ulmus racemosa)*, common.
Winged Elm *(Ulmus alata)*, common.
Slippery Elm, Red Elm *(Ulmus fulva)*, common.
Tulip Tree *(Liriodendron tulipifera)*, abundant.
Sycamore *(Platanus occidentalis)*, common.
Hackberry *(Celtis occidentalis)*, common.
Mulberry *(Morus rubra)*, common.
Sourgum *(Nyssa sylvatica)*, common.
Sweetgum *(Liquidambar styraciflua)*, seen along river shores.
Ironwood *(Ostrya virginiana)*, occasional.
Hornbeam *(Carpinus caroliniana)*, common.
Kentucky Coffee Tree *(Gymnocladus dioica)*, not common.
Honey Locust *(Gleditsia triacanthos)*, common.
Black Locust *(Robinia pseudacacia)*, along roads.
Redbud *(Cercis canadensis)*, common.
Flowering Dogwood *(Cornus florida)*, abundant.
Rough Dogwood *(Cornus asperifolia)*, along river.
Cottonwood *(Populus deltoides)* a few along river.
Silver-leaf Poplar *(Populus alba)*, introduced but common.

Black Willow *(Salix nigra)*, along river.
Longleaf Willow *(Salix longifolia)*, along river.
Redcedar *(Juniperus virginiana)*, abundant.
Sassafras *(Sassafras sassafras)*, abundant.
Papaw *(Asimina triloba)*, common.
Persimmon *(Diospyros virginiana)*, common.
Wild Plum *(Prunus americana)*, common.
Black Cherry *(Prunus serotina)*, common.
Chokecherry *(Prunus virginiana)*, common.
Crab Apple *(Pyrus coronaria)*, a few.
Thorn Apple *(Crataegus cordata* and *tomentosa)*, common.

SHRUBS

Buckthorn *(Rhamnus caroliniana)*, local.
Sourwood *(Oxydendron arboreum)*, common.
Huckleberry *(Gaylussacia frondosa?)*, not perfectly identified.
Farkleberry *(Vaccinium arboreum)*, common.
Blueberry *(Vaccinium* sp. ?), abundant.
Serviceberry *(Amelanchier canadensis)*, common.
Spicebush *(Benzoin aestivale)*, abundant.
Red Snowberry *(Symphoricarpos* sp.), abundant.
Blackberry *(Rubus villosus)*, common.
Dewberry *(Rubus trivialis)*, common.
Nannyberry *(Viburnum rufidulum)*, common.
Bladdernut *(Staphylea trilobata)*, a few seen.
Buttonbush *(Cephalanthus occidentalis)*, a few along river.
Hazelnut *(Corylus americana)*, common locally.
Witch Hazel *(Hamamelis virginiana)*, common.
Dwarf Sumac *(Rhus copallina)*, abundant.
Staghorn Sumac *(Rhus hirta)*, common.
Poison Sumac *(Rhus vernix)*, common.
Spiny Aralia *(Aralia spinosa)*, a few seen.
Spikenard *(Aralia racemosa)*, common.
Ginseng *(Panax quinquefolium)*, originally common, now scarce.

VINES

Chicken Grape *(Vitis cordifolia)*, abundant, full of fruit.
Southern Fox Grape *(Vitis rotundifolia)*, common.
Virginia Creeper *(Parthenocissus quinquefolia)*, common.
Green Briar; Cat Briar *(Smilax rotundifolia)*, abundant.
Glaucous Green Briar *(Smilax glauca)*, common.
Trumpet Creeper *(Tecoma radicans)*, common.
Crossvine *(Bignonia crucigera)*, occasional in woods.
Bittersweet Vine *(Celastrus scandens)*, common.
Poison Ivy *(Rhus toxicodendron)*, common.

GENERAL VEGETATION

Grasses are abundant and include the conspicuous brown Andropogons of the old fields and the abundant Kentucky blue grass of meadow and pasture lands, besides innumerable other native species.

Canes, or "canebrakes," grow along the shores and on the islands of Green River in dense pure stands, often 15 or 20 feet high and so close together as to be almost impenetrable. In the low forest bottomlands the smaller switch cane grows in low and scattered formation, but both of these belong to the Mississippi bottoms and are here on the upper edge of their range.

Exotic weeds have crowded much of the native vegetation from roadsides and old fields but in the woods or uncultivated land are abundance of the tall poke plants (*Phytolacca decandra*), beautiful in autumn with their purple leaves and stems and juicy purple berries on which the birds eagerly feast. The red and white berries of baneberry (*Actaea rubra* and *Actaea alba*) are also conspicuous in the autumn woods, as are the false Solomon's seal, spikenard, and many other berry and fruit-bearing plants.

In spring there is a rich color display of wild flowers, lavender, phlox, blue mertensias, purple water leaf, blue and white and yellow violets, pink geraniums, and spring beauties, blue and pink spiderworts, with acres of delicate blue Quaker ladies, and occasionally in shady spots great white and purple trilliums or wakerobins.

Later the dull purple jack-in-the-pulpit and ginger-root and yellow and orange jewelweeds blossom in the shady woods and the pink *Polygonum* (smartweed) shows up in masses of color in the wet places.

Towards autumn the Compositae (sunflower family) comes to the front and the waste places are rich with goldenrods and wild sunflowers, bright with purple and blue and white asters, pink spiked blazing stars, purple ironweeds, and pink *Eupatorium*. Yellow evening primroses and Saint John's-wort are also among the autumn flowers.

GREEN PLANTS IN THE CAVES

The open entrances of many caves allow the penetration of certain green plants as far as the light from outside makes possible their growth. This varies with different species, some stopping at the last trace of sunlight, others at the last clear daylight and still others back at the last vestige of twilight.

The old entrance of Mammoth Cave is a good example of a wide, gently sloping throat or tunnel, opening toward the northwest in the bottom of a timbered gulch, where the sun can not reach into the cave at all, thus affording a long gradual change from full daylight to total darkness within a few hundred feet.

Most of the forest plants stop at the entrance rim, but a few ferns, including the maidenhair, crowd into the throat beyond any possible touch of sunshine, several mosses, *Marchantia*, and a *Porella* reach down into the twilight of the tunnel, while a little flat green lichen and some of the green single-celled algae, or *Protococcus*, reach back into the very dim light toward the iron gate.

Far back in some of the well-lighted caves, where no trace of daylight has ever been, a fine growth of the delicate new shoots of mosses and a green tinge of single-celled algae cover the rocks or boards within a foot or so of the powerful electric lights, starting from spores brought in through the air or by contact with outside earth, and growing in purely artificial light.

FUNGI IN MAMMOTH CAVE

Numerous types of fungus growth occur in Mammoth and the surrounding caves but always where there is nitrogenous material brought in from the outside. Fungi, having no chlorophyll and obtaining their food from decomposing plant or animal matter, grow as well in the dark as in the sunlight. In fact, the common mushrooms have been successfully grown in prepared beds in one of the large rooms of Mammoth Cave, but the labor of bringing in stable manure and the distance from market have caused the abandoning of this mushroom garden, which otherwise would have been a success.

In the lowest, dampest levels of Mammoth Cave along the shores of Echo River was found a bunch of half a dozen edible mushrooms, apparently from casual examination *Coprinus atramentarius*, and near them were a few of the slender, little fairy-ring mushrooms, probably *Marasmius nigrapes*. Along the sloping banks of the subterranean river a railing of slender posts and poles with the bark left on showed many of the little bracket mushrooms, probably of the genus *Stereum*, growing on the decaying bark. All these types were found in other caves and seemed to be the commonest fungous growth except the molds.

Many types of molds are found in these caves as they are commonly in other caves of the country, but no attempt was made to collect or identify them. The most conspicuous and most beautiful of them all, probably one of the Mucoraceae, was seen growing on an old orange skin, stale sandwich, damp gunnysack, or decaying wood. It looks like white rabbit fur, only more delicate and silvery. The filaments are generally an inch or two long, like the finest spun glass that a breath of air would tear to pieces. Only by close examination in a good light can their beauty be appreciated. To what extent they furnish food for crickets and other forms of small cave life is not well known.

GAME AND WILD LIFE

Tales of the wealth of game in the early days of Kentucky are enough to thrill the hearts of sportsmen and naturalists of the present day and to kindle a determination to preserve a remnant of what is left for the interest of future generations. No time need be lost over regrets of the unnecessary waste of much of the game in the days of its abundance. It went fast, enabling the country to develop rapidly and produce a hardy race of pioneer settlers to cultivate the soil and build the foundations of a great commonwealth. The urgent need for the game is gone, there is ample food for all without it, but a land without its native wild life would be for many of us a poor place in which to live.

Fortunately, in parts of Kentucky there are goodly remnants of the larger game mammals and birds, and some of the

smaller game and fur-bearing species are still of value to local hunters and trappers. Some of these can be maintained indefinitely in reasonable numbers and some of the more desirable greatly increased by better methods of management. In the Cave Region, where many thousands of visitors come annually, the great attraction and educational value of a goodly representation of the native wild life needs no argument.

In our great national parks the wild life ranks high beside the wonderful scenery and natural phenomena, because of which most of the parks were originally established. In some cases the living things offer the greatest attraction and bring more visitors and students than any other single feature of the parks. Moreover, these extensive areas devoted to wild life are our only hope of maintaining for future generations many of our native species of mammals and birds.

With our parks serving as real sanctuaries for wild life, the increase of game should continually overflow into surrounding areas, where a moderate amount of well-regulated hunting could be allowed without endangering the existence of the species. In no other way can we hope to perpetuate many of our best game animals for sport or for study and the enjoyment of all.

Two factors are essential for a successful wild-life sanctuary. It must be large enough to provide cover and summer and winter food for a considerable number of animals, and it must be permanent. There should be adequate provision against overstocking the range and consequent starvation of the animals, and also against too close inbreeding of a few individuals. As intelligent care and management should be given our wild game as to our tame herds. Any tract that is maintained as a refuge until well stocked with game animals that have become unafraid of man and is then opened for hunting becomes a most disastrous game trap and affords the surest method of game destruction. Hunters, not sportsmen, can be found who will advocate this method and use every scheme for changing boundaries or opening a part of some well-established refuge, but their motives should be closely scrutinized.

Besides the game animals, which are generally the larger and more conspicuous species, there are great numbers of the

smaller and more obscure mammals and birds that can well be protected, encouraged, and maintained in such abundance as seems desirable in a suitable refuge. To a steadily increasing number of our people the interest in wild life is less dependent upon its food or fur value than upon its beauty, intelligence, habits, and relative position in the animal kingdom. In other words, interest and study of wild life are taking the place of practical utility in our estimates of values. The camera is largely taking the place of the rifle and shotgun, and a live animal in the bush is coming to be worth a dozen dead ones in the bag. As a result, the size of animals no longer determines their value. A hummingbird may be just as thrilling as a turkey gobbler.

In a study of animal life the fishes, reptiles, amphibians, crustaceans, insects, spiders, worms, and other invertebrates are interesting as well as the higher groups of birds and mammals.

II.—MAMMALS OF THE MAMMOTH CAVE REGION

VERNON BAILEY

VIRGINIA OPOSSUM: *Didelphis virginiana virginiana* Kerr

Opossums are among the commonest of the fur-bearing mammals of the cave region, and to a limited extent are cave dwellers. Their tracks are seen in the entrances of some of the larger caves but more commonly they occupy the small caves and crevices in the cliffs and ledges along the river bluffs, or sides of wooded ravines. Such rocky retreats have added much to their safety and abundance in the face of long and eager quest for their fur and meat.

"Possum hunting" at night with dogs is one of the remaining sports of the country boys and when the luckless opossum takes refuge in a tree top or even a hollow trunk or log he is usually an easy victim, but in his rocky den he defies all attacks. To the trapper also he contributes largely to the fur harvest and proves a valuable asset, prime skins in full long winter fur bringing two or three dollars in 1930.

Opossums breed several times a year and produce normally from seven to eleven young at a time, and as many as eighteen young have been known in a litter. This rapid increase accounts in large part for their present abundance and suggests great possibilities in fur production in either the wild state or under semidomestication.

In habits they are mainly nocturnal, hunting at night and sleeping during the day, unless hungry, when they will continue the hunt until food is secured.

Few animals are more omnivorous in taste, apparently nothing edible being refused as food. Fruits of all kinds are eaten, and especially such sweet fruit as ripe persimmons, blueberries, and blackberries. Some nuts and acorns are eaten and a great variety of insects and small animal life, meat of any kind, including fish, crustaceans, mice, birds, eggs, and any small game they can catch. In captivity they do well on table scraps and much of the waste that goes in the garbage.

THE VIRGINIA OPOSSUM

Fig. 6.—This is our only representative of the great order of marsupials with small brains and many peculiar characters, including a prehensile tail. They are valuable fur-bearing animals.

In autumn they become very fat and in cold weather in the northern part of their range spend considerable time in a lethargic condition, if not in complete hibernation. They make warm beds of leaves in safe retreats and sleep for a week or a month at a time, but come out on warm days and search for food. To what extent they become torpid is not well known, but when the temperature was down to ten degrees above zero, I have found them still warm but very sleepy in their winter nests.

In moderate numbers opossums do little mischief and their value for fur and food should warrant a reasonable degree of protection. Without protection they suffer great waste, as immature and unprime skins are taken in the early fall, when of only half the value they would have if left until midwinter.

BUFFALO; AMERICAN BISON: *Bison bison bison* (Linnaeus)

Buffalo once ranged over the valleys of Kentucky in great herds, their abundance being one of the attractions that brought the hardy hunters of Virginia and the Carolinas to this part of the country from 1750 to 1800. Already it was the battle ground of contending races of native hunters, attracted by the abundance of big game, but the white hunters, armed with deadly rifles, soon destroyed the Indians and one by one the most important species of game animals. More than a hundred years ago in Kentucky Daniel Boone complained to John James Audubon that the buffalo were all gone and one might walk for miles without seeing a deer or a bear. For him the country without buffalo or Indians was tame indeed, but he proceeded to show Audubon how to *bark* a mess of squirrels without touching one with a bullet, a remnant of the skill that had contributed to the destruction of both buffaloes and Indians.

Toulman, writing in 1792, said the buffalo were mostly driven out of Kentucky but some were still found upon the headwaters of Licking Creek, Great Sandy, and Green River. Doctor Allen says that Mr. Ashe, an apparently reliable authority, affirms that as early as 1806 not one was to be found in a wild state east of the Mississippi River (p. 510).

Before going the buffalo had contributed their all to the

building of civilization in this state and to the growth and vitality of a hardy race. They went rapidly and with much waste and before it was entirely necessary, but like the native races there was no place for them in the fertile areas. Securely fenced, a small herd imported from some area where they are now overabundant would bring to mind the early days of Kentucky and prove a great attraction to the descendants of the pioneers of this region.

WAPITI; AMERICAN ELK: *Cervus canadensis* (Erxleben)

Early records of the hunters and settlers of Kentucky refer to elk as common or abundant but these soon disappeared, apparently with the buffalo, a full century ago. They have left their names on many of the streams and towns in the state as reminders of their former abundance and general distribution. Their large size and delicious meat offered a premium on their early destruction and, unlike the white-tailed deer, they lacked much of the cunning and timidity which have preserved a few of these smaller animals to recent times. Like the buffalo, the elk could not survive in a settled country nor be endured if they could. They are fond of most cultivated crops, have no respect for fences, and little fear of man. Only in strongly fenced inclosures can they be kept on a definite area, but with suitable forage, browse, and water a limited number could be maintained to represent the native wild life of the region and to keep alive in the minds of future generations the early history of the state. A few kept in a small fenced pasture by the roadside where people visiting the caves could see them would add much of interest to the region.

VIRGINIA WHITE-TAILED DEER: *Odocoileus virginianus virginianus* (Boddaert)

The white-tailed deer, once abundant over all of Kentucky, is now rare or entirely gone over most of the state. At Mammoth Cave I was told that none had been killed for twenty years back although one had been seen only two or three years before in Deer Valley, a few miles down the river from Mammoth Cave. Another, a buck with horns, was reported seen on two occasions by William Brantford, one of the guides at

Mammoth Cave, during the unusually cold winter of 1917. Such scattered records mean little except that deer occasionally wander from their still precarious haunts in the mountains in the eastern part of the state, or from the river bottoms to the west. This, however, is important if any considerable area of rough timbered land should be set aside as a refuge or park in this part of the state for it would soon be stocked with such remnants of native game animals as are not entirely gone. The rough well-timbered valley of Green River is ideal deer range and would under present conditions support a considerable number of these animals if they could be protected from hunters and dogs.

A hundred years ago this region was described as a hunter's paradise, swarming with big game of which the native deer was the most important. Venison was always available to any good hunter and became the staff of life to the hardy race who wrested the wilderness from its native hunters. The debt we owe to these beautiful timid creatures can never be realized by those who have not lived in the pioneer days, but some of the history and romance of those days still clings to the native animal life, and so far as possible should be preserved for future generations as a part of our national heritage.

COTTONTAIL RABBIT: *Sylvilagus floridanus mearnsi* (Allen)

Bunny cottontails, after a century of almost unrestricted hunting, are still common wild game animals in Kentucky. Their tracks may be seen in the roads and trails of a morning, and the flash of a white cottony tail may be seen in the brushy thickets, or a brown bunny sitting in the road or beside the trail late in the evening. All through the woods the fresh green stems of catbriars, raspberry bushes, blueberry bushes, and young sassafras are seen nipped off as neatly as with knife or shears by the keen chisel-like incisors of these little rabbits, but the clover patches along the roads or in old fields seem to afford their favorite feeding grounds. In point of numbers and availability for hunting and the good meat afforded they may well be considered the most important game animal of the state.

The boy with a shot gun or with a 22-caliber rifle now gets his training in marksmanship, sportsmanship, and love of the outdoors in pursuit of the rabbit, in a small way comparable to that of his grandfather in pioneer days who provided venison and bears' grease for the family larder. Under well-regulated and appreciated game laws there is no better training in outdoor citizenship than conscientious hunting of the right sort in the right way, and no worse training than to turn the boy loose with a gun to shoot anything alive; just for fun.

KENTUCKY FOX SQUIRREL: *Sciurus niger rufiventer* (Geoffroy)

These beautiful big yellow-bellied squirrels, twice the size of the gray squirrel, and twice as valuable for game, are scarce in the Mammoth Cave region where originally abundant. A few are found along the river bottoms where tall sycamores and tulip trees afford safe retreats in their leafy tops and where old hollow trunks make the best of nest quarters for both old and young squirrels. Over the uplands and high ridges most of the old timber has been cut and these big squirrels are mainly in the big timber of the bottomlands wherever a trace of virgin forest remains.

The great abundance of nuts—black walnuts, butternuts, chestnuts, beechnuts, several kinds of hickory nuts—besides a long list of acorn-bearing oaks—afford a rich food supply for far more squirrels than are here at present. But for the men and boys and dogs and guns lined up against them for much of the year there would be far more of these desirable animals in the woods, and their heavy, gruff barking in the tree-tops would more often add a thrill of wild life to the beautiful stretches of remaining forest.

With a few good-sized game and wild-life sanctuaries these squirrels with other game animals could be protected and increased in abundance to any extent desired and enjoyed by the general public in their safe retreats while the increase could overflow to other areas where a limited amount of hunting could be maintained indefinitely. Only through such permanent refuges can we hope to keep any of our native game animals for the enjoyment of future generations.

CAROLINA GRAY SQUIRREL: *Sciurus carolinensis carolinensis* Gmelin

These small, southern gray squirrels have held their own over a century of almost unrestricted hunting and today are one of the most important game animals of the region. While so scarce and shy that the usual visitor rarely sees one, the skilled squirrel hunter with his dog and twenty-two caliber rifle can go out almost any day and get a mess of squirrels. At Cave City one day in late September a man brought in a bunch of eight grays although I had seen but two in exploring the woods for a week. Dogs are generally used in hunting them although still-hunting requires more skill and woodcraft and is often very successful. Since the days of the pioneers much of the skill of the Kentucky riflemen has been acquired through squirrel hunting and no better target practice could be found. Even today some of that skill is the pride of the younger generation of boys in the rural districts.

In writing of Kentucky sports about the year 1820, John James Audubon described a novel method of killing the squirrels called *barking* them (Vol. 2, p. 461). While out hunting with Daniel Boone near the town of Frankfort he says "we followed the rocky margin of the Kentucky River until we reached a piece of flat land covered thickly with black walnuts, hickories, and oaks. As the mast was good that year squirrels were seen gamboling on every tree around us. Boone pointed to one of these animals which had observed us and was crouching on a branch about fifty paces distant and bade me mark well the spot where the bullet should hit. . . . The ball hit the bark immediately beneath the squirrel and shivered it into splinters, the concussion killed the animal and sent it whirling through the air. Boone kept up his firing and before many hours had elapsed we had secured as many squirrels as we desired."

At the present time the gray squirrels are found mostly on the ridges and high country where chestnuts, hickorynuts, walnuts, and acorns abound and occasional hollow trees afford shelter and safe retreats. The dropping of nuts in the autumn or the soft barking, *chuff, chuff*, as the squirrels call back and forth to each other are heard more often than the squirrels

CAROLINA GRAY SQUIRRELS ABOUT HALF GROWN

Fig. 7.—Gray squirrels are delightful pets and easily kept around yards and grounds by feeding and tamed to any degree desirable.

are seen. Many big balls of dry leaves and twigs in the tree tops show the summer nests of the squirrels and even in winter these outside nests are sometimes made warm enough for the coldest weather.

There could just as well be many times more squirrels if hunting could be somewhat restricted and suitable sanctuaries maintained for their preservation, places where they could be safe and unafraid, and from which there would be a continuous overflow of the increase, not only here in the cave region but in other parts of the state.

SOUTHEASTERN CHIPMUNK: *Tamias striatus striatus* (Linnaeus)

Close to the old entrance of Mammoth Cave a couple of these pretty little striped ground squirrels were seen on several occasions as they came timidly out of the bushes on a big rock to pick up scraps from tourists' lunches, but very few were seen or heard during our visits to the Cave Region in spring or fall. During the summer months Giovannoli found them very scarce and attributed their scarcity to the great number of domestic and half wild cats running at large in the woods. There were a dozen or more of these feline predatory animals around the hotel at the Old Entrance of Mammoth Cave and cat tracks were seen in the roads and trails all through the woods. Dogs also of every color and variety of mixed breeds are numerous, and boys with twenty-two rifles help to keep the native animal life at a low ebb.

In this region of cutover forest land, old stumps and logs, rocks, and rail fences there is ample room for many more such attractive forms of small animal life. The chipmunks are sometimes mischievous in digging up seed corn in newly planted fields close to the woods, and being too small for game and food they are generally considered worthless and therefore to be destroyed. On the other hand, the fact that they have a practical value as tree planters is rarely taken into consideration, and their aesthetic value as beautiful, interesting little animals, easily tamed and attracted to the hand by feeding and

gentle methods of approach, is rarely given its true value. In our great national parks the enjoyment of contact with these timid creatures and the delight of winning their confidence are coming to be one of the great charms of the wilderness areas.

CAROLINA CHIPMUNKS ARE PRETTY LITTLE ANIMALS

Fig. 8.—They are very shy and timid but are easily tamed by feeding and protecting them from cats and dogs.

SOUTHERN WOODCHUCK: *Marmota monax monax* (Linnaeus)

Woodchucks or groundhogs are locally common over this rough country and especially so along the mellow-soiled valleys where the richest farm lands are located. Their burrows are seen in fields and through the woods where there is soil to burrow in, and on the rocky slopes they live in cracks and caverns of the ledges. They often enter the openings of caves but do not go far back into the deeper recesses. Their tracks were seen in the entrances of Dixon, Long, and Bat Caves, and they come into Mam-

moth Onyx Cave through a small opening at the rear, a back door of their own. They seem to live in small side tunnels near the entrances of some of the caves and may even hibernate in them during the cold days of winter, but they are mainly burrowers, not real cave dwellers. Their residence in the caves is more or less temporary.

Like most of the squirrel family, woodchucks are diurnal, carrying on their usual activities during daylight hours and sleeping in safe dark retreats at night, and when not busy during the middle part of the day.

Their food is entirely vegetable matter, largely clovers, grasses, and many small succulent plants, flowers, seeds, and roots. They are fond of most field and garden crops, such as peas, beans, a great variety of vegetables, growing grains, green corn, and even ripe corn and other grains. In captivity, they are delightful pets, and are especially fond of rolled oats, bread, and carrots.

In the fields they often do serious mischief, besides making large burrows and mounds of earth, eating considerable of the crops and trampling down even more than they eat. To the farmers and farmers' boys they are generally considered enemies to be destroyed on every possible occasion. They are shot, trapped, poisoned, and hunted with dogs, or dug out with pick and shovel until their numbers are generally kept fairly under control. Leonard Dawsey at the Mammoth Cave Ferry told me that he had trapped and shot about forty woodchucks in and around his cornfield during the summer of 1929.

The Biological Survey of the U. S. Department of Agriculture has for free distribution Leaflet No. 21, on Woodchuck Control in the Eastern United States, which will be helpful to many farmers where real loss is sustained.

The fact that woodchucks are true squirrels, of cleanly habits, strictly vegetarian in diet and excellent food if properly prepared and cooked would, if commonly appreciated, help to control their abundance and protect the crops.

Let's call them whistling squirrels, and go out and get a nearly full-grown young of the year in October, doing

some good still hunting to get within sure rifle range and shooting it through the head or neck as it stands up near the burrows. A twenty-two caliber rifle with good sights, long shells, and smokeless powder will do. As soon as the whistling squirrel is really dead, we will remove the internal viscera, allowing all the blood to escape and as soon as we

A MOTHER WOODCHUCK AND HER TWO YOUNG

Fig. 9.—Woodchucks are very shy and timid animals but can be tamed and made delightful pets if gently handled.

get home skin and cut up the meat and put it in cold salt water to soak for a few hours before it is cooked.

A full hour before supper we will rinse off the salt and put the meat in a stew pan with just enough hot water to cover it, drop in two slices of bacon or fat pork, and slice in one small onion. Let it cook for a full hour under a close cover until the water is nearly gone, the meat is tender

enough almost to drop off the bones, and the juices are all cooked back into it. Now let's see if it is not good. I have fooled old timers into thinking it squirrel and enjoying it thoroughly.

The fact that their overabundance has to be controlled should not lessen our interest in the squirrels as wild neighbors nor destroy our friendly feelings for gentle, timid animals with no worse vice than a hearty appetite. It would be a hard-hearted observer who could watch a mother woodchuck feeding and caring for her young without feelings of friendly sympathy and generous well wishes.

EASTERN FLYING SQUIRREL: *Glaucomys volans volans* (Linnaeus)

Flying squirrels are said to be common in the timber about Mammoth Cave but Giovannoli secured only one specimen after much hunting and pounding on hollow trees. The cats had probably killed most of them, as they are easily caught at night when they come to the ground in search of food. They are beautiful, soft-furred, big-eyed little animals, strictly nocturnal, sleeping during the day in holes or hollows high up in tree trunks and coming out for their evening activities soon after dark.

They usually run to the top of their tree, jump with widespread membranes into the air and soar away to the next tree, alighting always lower than where they started, but making rapid progress through the forest by running up and soaring across from tree to tree. The wide, flat tail serves as an effective rudder and guides them skillfully to the tree trunk on which they alight with an upward curve and a soft pat of the furry feet.

The four to six young are raised in soft nests in safe hollows of trees, or sometimes in warm nests of bark and grass among the branches in the tops of dense leafy junipers.

Before the acorns and tree nuts are ripe much of their food is obtained on the ground or from bushes and seed-laden plants, and they quickly acquire the habit of visiting camp grounds to pick up crumbs and scraps of scattered food. In fall and winter their main food is supplied by

acorns, beechnuts, chestnuts, hickorynuts, hazelnuts, and many tree seeds and berries. In food habits they are more omnivorous than most squirrels, and besides nuts, seeds, and berries they will eat insects and meat. They have been known to kill and eat young birds in the nest and also to eat birds' eggs, but generally they are harmless and interesting forest neighbors.

When taken young they make delightful pets, are very gentle and affectionate, but usually are sleepy during the day and most playful at night. Their nocturnal habits are, however, a real advantage in domestication as during the evening we are likely to have time to play with them and they are safely asleep when we are busy or away during the day.

HOUSE MOUSE: *Mus musculus musculus* Linnaeus

House mice are generally abundant around buildings in spite of the numbers of cats kept as pets and as protection against such pests. At one of the cave hotels an old mouse and five small young were found in the top drawer of our bureau in the best room of the house. Their nest was only a few bits of paper so I gave them some cotton, food, and water to see if comfort and affluence would improve their manners, but they did not show much appreciation of generous treatment nor any confidence in my good intentions. Moreover, they were so unpleasantly smelly that they were not good neighbors nor welcome guests. Cats can hardly be blamed for not liking them nor for preferring birds and other small game as a regular diet.

One of the worst sins of these Old World mice, however, is lending the name *mouse* with all its bad reputation to so many of our small native rodents, generally attractive little animals lacking the strong odor, destructive habits, and parasitic characters of the real house mouse.

Tight walls, doors, and floors are the best protection against these house pests but small snap traps baited with a bit of bacon or any cooked meat and rolled oats will keep a house free of them for most of the time.

BROWN RAT; HOUSE RAT: *Rattus norvegicus* Erxleben

The common house or brown rats are found in and around most of the buildings of the cave region and even in the entrance of some of the caves, but they do not find sufficient food or comfortable living conditions to attract them far back into the caves nor to afford a permanent abode. Old and ill-kept farm buildings and village stables are their favorite resorts but in summer many take to the fields, where weeds and brush and old fences afford cover. Food supply is the great controlling factor in their range and abundance, and their control is most easily accomplished by keeping all food securely shut away from them.

House cats make little impression on their abundance but they must have good cover to escape from their arch enemies, the owls, ever on the watch for them at night and seeming not to mind their rank odor and filthy coat.

Natives of the Old World, these rats came to America in ships as early as 1775 and have spread over most of the New World. They are well considered the most destructive and injurious mammal of the whole world and more efficient methods of combating them are constantly being sought. The methods found most effective are given in the latest bulletins and circulars of the Biological Survey, U. S. Department of Agriculture.

ALLEGHENY WOOD RAT: *Neotoma pennsylvanica* Stone

These large native wood rats with large ears, bright eyes, and long whiskers are as pretty as squirrels or any of our wild rodents. In no way do they resemble the brown rats except in size and general form, and they belong to a different family of rodents, to the family Cricetidae instead of to the Muridae.

They are common along the limestone cliffs and in most of the caves and more than any other rodent are real cave dwellers. Giovannoli caught them two miles back in the chambers and in many cases they follow the whole length of extensive passages, although rarely found in the deeper and damper lower levels. Their dainty round tracks are seen in dusty places far back in the tunnels, usually

along the edges of the floor or on dry shelves leading to little side holes and cracks in the walls where they have soft nests and safe retreats.

The specimens collected had green food in their stomachs, indicating visits to the surface, probably through cracks and narrow openings between the rocks. They are great climbers and with their short curved nails are able to run over the walls and up rocky slopes where few animals can go. How they find their way in the total darkness of the caves is probably explained by their long vibrissae (moustaches) vibrating sensitively from the sides of the nose and each implanted in a large nerve bulb at the base. These are surprisingly comparable to the very long antennae of the cave crickets and undoubtedly serve the same purpose in somewhat different manner. The prominent black eyes of the wood rats are well developed for nocturnal use and readily adjustable to bright daylight, but it is hardly conceivable that there can be any real vision where there is no trace of light.

The food of these wood rats is entirely vegetable matter, mainly green foliage, seeds, grain, or nuts. They will eat any scraps of bread or lunch material found in the caves, but so far as we know do not eat the crickets or any insects or other animal food. They will gnaw bones, hoofs, or horns but probably for the mineral matter rather than as food.

Among the rocks outside they often build considerable heaps of rubbish, sticks, stones, bones, or any small objects they can handle, as fortresses to protect their real nests back under the rocks. They rarely if ever build stick houses out away from the rocks as do some other wood rats.

The four young are born and raised in soft warm nests in safe retreats among the rocks or in narrow cracks and holes in the caves.

Occasionally these rats get into deserted camps or houses in the woods and make themselves at home, building nests on shelves and in dark corners. They rarely do any serious mischief and are easily caught or destroyed if the rightful owners of the houses return. They are never

in this region serious pests or of any great economic importance.

WHITE-FOOTED MOUSE; WOODS MOUSE; DEER MOUSE: *Peromyscus leucopus leucopus* (Rafinesque)

These bright tawny, black-eyed woods mice with their pure white feet, white bellies and lower surface of tail, are among the commonest small rodents of the Mammoth Cave region. They are primarily forest dwellers but will accept any safe cover such as brush, thickets, weed patches, rocky ledges, and the entrance of caves. Several were caught in the entrance of Mammoth Cave and tracks were found in the back ends of Buzzard and Dixon Caves, where they had easy access to the surface. No trace of them could be found far back in any of the larger caves nor did they touch the rolled oats used for bait by Giovannoli while trapping for cave animals in the deeper caverns. With the wealth of food, seeds, and nuts in the forests here they are evidently not attracted by a mainly cricket diet to which they would be limited in the caves, although the crickets are generally abundant.

They are harmless and rather attractive little animals, though strictly nocturnal and rarely seen except when their nests are disturbed in some dark retreats, as in hollow logs or trees, or in some old boxes or buildings. Their big ears and bright eyes give them a lively, intelligent expression and when tamed they make gentle and interesting pets, very active and fond of running on wheels in their cages. They breed readily in captivity and are far more interesting and intelligent than the white mice, mere races of house mice, so generally used as pets.

MERRIAM HARVEST MOUSE: *Reithrodontomys humilis merriami* (Allen)

These rare little mice have not been taken in the Mammoth Cave region nor nearer than Lexington, Kentucky, but as they occur both north and south of the caves they will undoubtedly be found here when more thorough collecting is done. They are the smallest of the rodents of this

region, tiny dark buffy brown mice with grayish white bellies and small ears, somewhat resembling a half-grown house mouse. The one infallible character, however, is the deep groove along the front of each tiny upper incisor. An adult will measure about 113 millimeters in total length; tail, 54; and hind foot, 16 millimeters.

They are ground mice, living usually under fallen grass in old fields or pastures, or along weedy fence rows, and making well-defined little trails or runways under the grass and cutting grass stems along the way for food. Their runways are like those of meadow mice, but much smaller and are easily recognized.

BLUEGRASS PINE MOUSE: *Microtus pinetorum auricularis* Bailey

[*Pitymys pinetorum auricularis* of Miller and of Anthony.]

These little smooth-furred, short-tailed, dark brown voles, or field mice, have been taken at Hickman, Kentucky, to the west and Eubank and Quicksand to the east of Mammoth Cave, as well as at points north and south, though not in the immediate vicinity. They are obscure little animals, rarely seen except when secured by experienced collectors who know how to find their little roadways under the grass and weeds, and they undoubtedly have a more general distribution over the cave region than is now known.

They live mostly in open sandy woods or old overgrown fields or orchards, where they keep closely under cover of dense vegetation, or in shallow burrows under the surface of the ground, often pushing up ridges in mellow soil like mole ridges, so they can move from place to place entirely concealed from a host of enemies overhead.

In places their burrows open out to the surface with little side doors where the voles come out under cover and gather their food of green grass stems, clover, and other plants, which with roots, bulbs, and bark found under ground supply most of their food.

In Kentucky there have been few complaints of their injury to orchard trees, but in other states they have killed so many apple trees by eating the bark from the roots in

winter as to cause heavy losses and to win the name of apple mouse.

MUSKRAT: *Fiber zibethicus zibethicus* Linnaeus

Muskrats are generally distributed along streams and in ponds and marshes of this region but the high price of their fur in recent years has caused a great scarcity of individuals at the present time. On a seven mile boat trip down Green River below Mammoth Cave I saw no tracks or other signs of muskrats, but the ferryman, Leonard Dawsey, told me that they had been common along the river and that an old trapper in 1927 had taken as high as eighty muskrats from his traps on a morning's round. Dawsey saw the dead rats in the boat and accepted the number as probably correct. Such facts readily explain their scarcity at the present time and illustrate the waste of unrestricted trapping.

Along the streams and in many of the lakes and ponds the muskrats live entirely in the banks where they are generally safer than in their houses in shallow lakes and marshes. There is abundant food of sedges, cattails, roots, and shore vegetation for considerable numbers of these valuable fur bearers and most of this food is wasted with few muskrats to eat it. Wise conservation of such natural resources means increased and continuous revenues.

BEAVER: *Castor canadensis* subspecies?

No beavers have been known in this region for a generation or more, but from 1750 to the time when the country was well settled for permanent homes in 1800 beavers were abundant and trapping an important industry. There are still many place names commemorating their former abundance and old beaver dams are said to be still visible on Beaverdam Creek just west of Mammoth Cave.

There are many places along Green River and some of the smaller streams of the vicinity where a moderate number of beavers could live without doing any damage to private property and would utilize much waste and worthless vegetation for food. In other places they would get

into orchards and farm crops growing close to the streams and make trouble for the farmers and for themselves.

A few could be kept in a suitable inclosure in any park or private grounds, where their interesting habits could be observed by visitors. As they are natives of the region, it would be well worth while to reestablish a colony to keep alive their historic association with the early development of the state, and to pass on to future generations as many as possible of the valuable indigenous mammals.

PANTHER; COUGAR: *Felis concolor couguar* Kerr

In 1770 Daniel Boone in the Bluegrass region of Kentucky reported buffalo, elk, and deer as extremely numerous, and so were black bears; while wolves and panthers were plentiful (Roosevelt, Winning of the West, Part 1, p. 180). Most of the writers in the early days of the state speak of them among other of the larger animals, either feared or hunted for sport. After the big game had gone their destruction of domestic stock led to their rapid extermination and for a long generation back they have not been found on most of their old range. Leonard Dawsey at the Mammoth Cave ferry over Green River is sure there have been none in that vicinity for forty years back, and I could get no actual record of their being killed in the cave region. Still it is almost certain that at one time they inhabited some of the caves now visited daily by large numbers of people.

EASTERN BOBCAT: *Lynx rufus rufus* (Schreber)

Bobcats were once common throughout this region and undoubtedly occupied the more open parts of most of the accessible caves, but now they are practically gone. Leonard Dawsey told me of one being taken by a trapper two or three years before (1926 or 1927) near Mammoth Cave but he doubted if any were still to be found.

These dark gray forest cats, with tails only six inches long, tasseled ears, and conspicuous side whiskers, are stealthy hunters, delighting in forests, cliffs, and caves. The small caves or openings between limestone ledges are

probably their favorite retreats but the larger caves of other sections are often entered by them as shown by skeletons found far back in dry rooms where they were preserved from decay until mummified or petrified.

Their food is mostly small game such as rabbits, squirrels, wood rats, and such birds as they can capture. In size they are about that of a small setter dog, weighing usually about 20 pounds but sometimes up to 30 pounds.

RED FOX: *Vulpes fulva fulva* (Desmarest)

A few red foxes are said to be taken each year in the cave region, but they are by no means as common as the gray foxes nor so easily trapped or hunted. They keep more to the open country and depend upon their speed and cunning for protection, often giving the hounds a long and fruitless chase. They are not easily trapped but the more experienced trappers get a few, and their beautiful yellow-red fur is the most valuable of any in the region.

Red foxes are fond of poultry and miss no chance to pick up any kind that strays within their reach. They undoubtedly get some small game—quail, rabbits, and squirrels—but in their present numbers can do no very serious harm. There are few reports of any mischief. They partly balance the account with the farmers by eating large numbers of mice and small rodents that would cause some damage to crops. Their value for fur and for the hunt gives them the advantage of public favor which is often more effective than legal protection.

GRAY FOX: *Urocyon cinereoargenteus cinereoargenteus* (Schreber)

Gray foxes are fairly common in the cave region, especially in the forest and rough country. They are no match for any good dog in speed and depend on cover for protection, either in safe dens among the rocks or in small caves. If too hard pressed they will climb to the top of the nearest tree and hide among the branches, safe from the dogs but not from hunters. Their numerous rocky retreats are their best protection. Apparently they do not go far back in any of the

larger caves but in those not often disturbed they may find congenial homes near the entrance. Small caves that admit no larger animals are, however, their favorite resorts for both living and breeding quarters.

They are good hunters, depending mostly on small game, mice, squirrels, rabbits, quail and other birds, and any poultry that comes their way. Also they are fond of insects and fruits and berries in season.

Their pretty gray fur with rusty brown sides and throat and the crested tail with black stripe and tip makes up into attractive garments, neck pieces, and trimmings, and is much used. The usual price of skins is not high, generally three to five dollars, but sufficient to keep the number of foxes down to a harmless stage. The only protection they need is the limiting of trapping to the season of prime fur, when it brings the highest prices, preferably in December, January, and February.

SOUTHERN WOLF: *Canis lycaon floridanus* Miller

We can now only assume that the small dark gray or black wolf of Florida and the southeastern states was the form reported as abundant in Kentucky by the pioneer hunters of 1770 and the fifty years following. The animals are all gone now from the settled areas and probably from the whole state. At Mammoth Cave I could get no records for at least forty years back. In the days of buffalo and elk the wolves were generally mentioned much as they were later in the West, as hanging around the herds of big game. As the game disappeared the wolves turned their attention to the settlers' livestock and this led to their rapid destruction by every possible means.

About the year 1820 John James Audubon described one method of capturing wolves in western Kentucky. He had stopped with a farmer for the night and in the morning was asked if he would like to go to the wolf traps, an invitation which he eagerly accepted. It seems that the wolves had killed the farmer's whole flock of sheep and one of his colts and the man had resorted to the old Indian method of capturing them. He had dug deep pits across the trails and covered the narrow tops with tilting frames over which leaves were strewn.

When the two men approached the traps the first two were empty but in the third three wolves, one black and two grizzled, were found cowering in the bottom of the pit. Audubon held up the door while the farmer went down with his knife, cut the "hamstrings" of the wolves, then threw a rope over their necks and drew them up, one at a time, for his dogs to kill, just to train them for good wolf dogs. Thus crippled and unable to stand two of the wolves were killed by the pack of cur dogs but the third fought so savagely that it had to be dispatched with an axe to save the lives of the dogs.

See Audubon and Bachman, Quadrupeds of North America, vol. 2, p. 129, 1851. Also Audubon and his Journals, vol. 2, p. 499.

EASTERN BLACK BEAR: *Euarctos americanus americanus* (Pallas)

In the early days of Kentucky bears were one of the very important game animals and were reported as abundant all over the state. Now they are all gone unless a few may be found in the mountains of the eastern part of the state. At Mammoth Cave I could get no records of any having been killed or seen for forty years back although as previously noted tradition credits the discovery of the cave to a wounded bear that was followed by a hunter named Houchens into the old entrance of the cave in 1809.

In 1798 Hawkins, in writing of the Creek Indians, said the bears had been exceedingly abundant at one time, so much so as to become one of the main props of the Creek larder, furnishing flesh and fat and especially oil for cooking. So valuable were they that the Indians hit upon a novel plan of preserving them, each town putting aside a great tract of land which was known as the "beloved bear ground" where the bears were unmolested except at certain seasons when they were killed in great numbers (Roosevelt, Winning of the West, Vol. 1, p. 82, 1900).

In the days of the early white settlers in Kentucky every man was a hunter and until the farms were cleared and crops and livestock raised to meet the family needs all were forced to depend very largely upon game, of which venison and bear meat and fat were of first importance. As soon, however, as pigs and sheep were raised in numbers to supply the demand

for meat and fat the bears ceased to be of great importance and often became pests by their destruction of crops and livestock. Only on the edges of rough country and in great swampy bottoms did they remain for long after the country was well settled, and even in such favorite areas they are now gone. Their interest has become historic but is so closely interwoven with the early history of the state that it will never be forgotten, and if some rough and picturesque mountain valley not needed for other uses could be set aside as a "beloved bear ground" a few of these interesting animals might still be preserved for the benefit of future citizens.

RACCOON: *Procyon lotor lotor* (Linnaeus)

Raccoons are still fairly common throughout the Mammoth Cave region, thanks to the caves and cavities in the cliffs and rocky ledges where they find man and dog-proof retreats. Coon tracks were seen in the entrance of Dixon Cave, Bat Cave, and along the shores of Green River. Giovannoli collected a specimen in a cornfield near Mammoth Cave and reported them caught by trappers every winter in considerable numbers. The night hunt with "coon dogs" is one of the favorite sports of native hunters and for this purpose many mongrel dogs are kept.

The country is rich in food and shelter for such animals. Caves and cliffs, hollow trees and logs, afford comfortable living quarters and many safe dens for the winter's hibernation. There are acorns, nuts, berries, and other fruits, and green corn in its season is a great attraction. Fish, frogs, crustaceans, and mussels are eagerly sought along the shores of streams and ponds, some small game is occasionally captured and birds' nests robbed for food.

In a good nut year raccoons become fat before the coldest weather begins and in this climate probably hibernate rather irregularly. Farther north they have a long period of hibernation through several of the cold winter months and come out with the melting of the snow in spring.

In small cornfields near the woods and rarely in poultry houses the raccoons do some mischief, but this is usually not of a serious nature or enough to cause complaint. The interest of the night hunt, the value of the fur, oil, and meat are gen-

erally considered fair compensation for the damage. Many are fond of the meat and consider roast raccoon next to roast opossum as a delicacy.

The fur of the raccoon is a part of the trapper's regular harvest but much of its value is lost by its being taken when unprime or before the animals are half grown. Live trapping, so young animals could be released or kept until full grown, would save much waste.

MINK: *Lutreola vison mink* (Peale and Beauvois)

Minks are scarce along Green River but the trappers still get a few every winter. The high price of their fur during the past ten years has brought them to the verge of extinction over much of the country, but in a rough and partly wilderness region such as this they will hold out for a long time against very severe trapping. With better protection they could be kept up to a more profitable abundance and the value of the annual fur supply greatly increased.

The dense growth of vegetation, weeds, bushes, and canebrakes along the banks of streams not only afford cover and safe retreats for mink but harbor a great variety of small animals, frogs, crustaceans, mice, and birds on which they feast, while the water is teeming with fish and other animal food much to their liking. A moderate abundance of mink along such streams would do no serious harm and would produce a valuable fur crop if properly managed. A few seasons of rigid protection would bring them back in any abundance desired.

NEW YORK WEASEL: *Mustela noveboracensis noveboracensis* (Emmons)

Weasels are said to be very scarce in the cave region but one is occasionally taken by the trappers and they seem to be generally distributed over the state. Specimens from northern Kentucky are referred to this form, and probably it is the one represented over most of the state. Farther north they change to white in winter but in this latitude they generally retain the brown coat with white belly and the black tip of tail persists throughout the year.

These weasels are bloodthirsty hunters, living largely on mice, birds, and small game. Their destruction of rodents is of some value to agriculture, but in Kentucky there are few of the meadow mice on which they largely subsist farther north, and it is just as well that they are scarce. They have practically no fur value and their destruction of small game, birds, and occasionally poultry would render them undesirable neighbors if abundant in this region.

RIVER OTTER: *Lutra canadensis canadensis* (Schreber)

The older residents of the Mammoth Cave region remember that otters were once common along Green River but the latest record I could obtain was of one caught about 1910 just below the old entrance of Mammoth Cave. The high price of their fur has practically eliminated them from this region, although early in the history of the state they were counted as one of the common and most valuable fur bearers.

With the abundance of their favorite food—fish, frogs, and crustaceans—in the streams of Kentucky, there could be a considerable number of otters maintained at a profit and without any loss. Their consumption of crustaceans and the abundant slower fishes—suckers, carp, and minnows—would be a benefit rather than an injury to better grades of fishes. They rarely leave the water to hunt for other game and are one of the least harmful of the musteline fur bearers.

Their fur is one of the really beautiful, durable, and valuable types of the region and would add greatly to the importance of the catch of local trappers if the animals were protected and maintained up to the practical limit of available food supply. This would not mean a great number of otters, for they are large animals and hearty feeders, but with a few along every stream the total value of their fur yield would add considerably to the present meager fur harvest.

There are still a few otters on the larger rivers, and if effectively protected these would increase and spread out to their original haunts. They are great travelers and

would follow the streams where the best food supply attracted them.

EASTERN SKUNK: *Mephitis nigra* (Peale and Beauvois)

Skunks are not numerous in the cave region. Giovannoli reports one killed by dogs near Green River, just above the mouth of Mammoth Cave and others seen along the highway near Cave City. I saw a few tracks and a hole

LIGHT AND DARK PHASES OF THE EASTERN SKUNK

Fig. 10.—The mainly black skins of these fur bearers are considerably more valuable than the skins with broad white stripes.

where one had dug out a hornet's nest near the mouth of Great Onyx Cave, and was told that the trappers get a considerable number each winter. Their skins form an important part of the fur crop and they hold out better against heavy trapping than most fur bearers. The abundant holes under rocky ledges help to protect them but they readily dig their own burrows where those of other animals can not be found.

Their food habits are generally considered useful to the farmer, as they live largely on grasshoppers, crickets, beetles, grubs, mice and other small rodents. They undoubtedly get the eggs and young of some ground-nesting birds and on rare occasions steal hens' eggs or chickens in unprotected poultry yards. In moderate numbers, however, they do little mischief and are of considerable value.

ALLEGHENIAN SPOTTED SKUNK: *Spilogale putorius* (Linnaeus)

Some form of the little spotted skunk occurs in the cave region and is well known to the trappers. A few are taken each year, their pretty black and white spotted and striped coats forming a part of the fur crop although not an important part. No specimens were secured to show the form occurring here but it is probably the Alleghenian.

These little weasel-like skunks are as pretty and graceful as any animal you can find and except for their powerful skunk-like odor are most attractive pets. They are skillful tree climbers but live more among the rocks, in caves and cracks and cavities of the cliffs, or burrow under or between ledges of rock. They are great mousers and love to hunt in caves or along rocky shelves where mice and wood rats are to be found. They do not usually range far back in the caves but keep near the openings and along the shelves and walls where there is still a trace of daylight and they can go out and in at will. They can not be considered real cave dwellers but rather cliff dwellers with a varied range.

Besides small rodents and occasionally a bird, they feed largely upon insects, grasshoppers, crickets, beetles, and other insect life, also to some extent on berries and any fruit in season. They often become very fat but apparently do not hibernate, at least for any considerable period.

Their fur is soft and fine, and in recent years has become fashionable for ladies' coats, its intricate pattern of white spots and narrow stripes on a jet black base proving very attractive. It is also light and durable and makes garments that are both warm and beautiful.

PRAIRIE MOLE: *Scalopus aquaticus machrinus* (Rafinesque)

These silvery, velvet-furred moles are generally common over the ridge tops and in the river valleys, in fact all over the cave region where there is mellow soil to burrow in. They are just as common in the deepest forest as in the open fields or on lawns, the name of prairie mole being applicable only in that part of their range where there are prairies.

THE PRAIRIE MOLE

Fig. 11.—These burrowers have lived so long under ground that their very small eyes have become atrophied and functionless, much the same as the eyes of cave-dwelling species.

Their characteristic ridges of earth, pushed up in extending underground tunnels in search of food, often form a devious labyrinth or network of rope-like wrinkles over the surface of the ground, quite conspicuous on well kept lawns, in gardens, or clean fields, but in the grassy pastures or leafy woods only noticeable as one walks over the ground and feels his feet sink into the hollow tunnels under the soft ridges. The moles are mainly insectivorous and extend their tunnels in search of angleworms, cut-

worms, grubs, and the hosts of small invertebrates found below the surface and largely injurious to vegetation. In lawns and gardens they sometimes mar the surface of turf or disturb some of the garden vegetables in their pursuit of the real enemies of plant life underneath, but with a better knowledge of their habits we can well overlook the slight mischief for the real good they do. In fact, some very intelligent people consider a few mole ridges and mole hills a real addition to the interest of their lawns and grounds.

CAROLINA SHORT-TAILED SHREW: *Blarina brevicauda carolinensis* (Bachman)

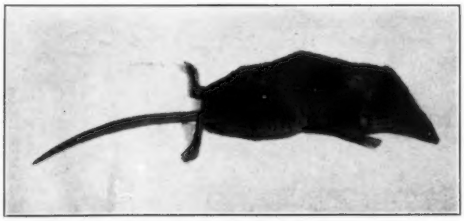
These medium-sized short-tailed shrews with slaty gray, velvety fur, long pointed noses, minute eyes, and invisible ears are among the commonest small mammals of the Mammoth Cave region, living in burrows and concealed runways under old logs, leaves, and fallen grass so that they are rarely seen alive. They have few natural enemies, as their disagreeably musky odor renders them unpalatable to most carnivores. Cats and foxes often leave them in the trail when killed, but the owls sometimes swallow them whole.

Like the other shrews and moles, they are insectivorous in food habits and spend most of their time seeking for small animal life under or on the surface of the ground. In mellow woods earth they just worm their way through the soil without even leaving a burrow, and with the flexible snout recognize their prey as soon as it is touched without the aid of eyes. In general their food habits are considered beneficial to the farmer and give little cause for criticism.

SMOKY SHREW: *Sorex fumeus fumeus* Miller

These little long-tailed shrews with blackish, velvety fur, almost as dark on the belly as on the back, seem to

be fairly common among the rocks in the mouth of Mammoth Cave where spring water from the roof trickles down in several little cold streams and keeps the stones beneath wet and cold and moss-covered for most of the year. It is just such a cold spot as one might find in the mountains, which probably accounts for these northern animals being found here and nowhere else in the vicinity. Giovannoli took three specimens in this spot and my traps yielded one the first night. Only oatmeal was used for bait on my



THE SMOKY SHREW

Fig. 12.—These little sooty colored shrews are found in the cool twilight of the Old Entrance of Mammoth Cave where cold spring water drips over the moss-covered stones. Their very small eyes are functional at close range.

trap and the shrew was evidently caught by accident as he ran across the trigger. Evidently the shrews were not attracted by the cave so much as by the cold air and wet ground under the cover of mossy stones. The range of the species is given as Canadian and Transition Zones of the Eastern United States, south in the mountains to North Carolina and Tennessee. This seems to be the first record for Kentucky and this colony may date back to post-glacial times when a Canadian Zone climate spread over this part of the state. They were living well within the entrance of the cave and may be fairly considered cave inhabitants.

KEY TO BATS OF THE MAMMOTH CAVE REGION

Bats are the real cave dwellers among mammals, but there are so many distinct species so similar in appearance that careful study is necessary to distinguish them. The following key will aid:

Tail membranes hairy above.

Ears short and rounded, not much exceeding the fur, hairy back of edges.

Size large, wing-spread about 16 inches, color light gray over yellowish brown — Hoary Bat, *Nycteris cinerea* *

Size medium, wing-spread about 13 inches, color rusty or buffy yellow, ears yellow, membranes brown — Red Bat, *Nycteris borealis*

Ears of moderate length, naked, wing-spread about 12 inches. Color blackish with frosted back — Silver-haired Bat, *Lasionycteris noctivagans**

Tail membranes wholly or mainly naked above and below.

Ears very long, well over an inch in length. Color sooty brown, wing-spread about a foot — Rabbit-eared Bat, *Corynorhinus rafinesquii* *

Ears about half an inch long or less. Size large, about 4½ inches in total length, wing-spread about 13 inches. Color dark brown, membranes blackish — Big Brown Bat, *Eptesicus fuscus*

Size smaller, not over 3½ inches in total length, wing-spread not over 11 inches.

Upper incisors only two, color dark brown above and below, membranes blackish — Rafinesque Bat, *Nycticeius humeralis*

Upper incisors 4, size medium. Ears reaching well beyond tip of nose when pressed forward. Color light brown above — Sharp-eared Bat, *Myotis keenii septentrionalis*

* Occurs in the general region but specimens not taken at the caves.

Ears not reaching beyond tip of nose when pressed forward.
Size medium.
Humerus about 40 mm. (1⅝ inches) long. Color light grayish brown, grayish below ---------- Gray Bat *Myotis grisescens*

Humerus about 38 mm. (1½ inches) long or less.
Color rich brown above, lighter brown below ---------- Little Brown Bat *Myotis lucifugus*

Color sooty above, dark gray below -- Little Sooty Bat *Myotis sodalis*

Size small. Humerus about 32 mm.
Color dark rich brown with black face Least Brown Bat *Myotis subulatus leibii*

Color yellow or fulvous, tinged with gray ---------- Georgia Pipistrelle *Pipistrellus subflavus*

HOARY BAT: *Nycteris cinerea* (Beauvois)

These big gray bats with soft chinchilla-like fur, round heads, and a set of savage bulldog teeth that they show upon the slightest provocation, are never common anywhere, but have been found on all sides of Kentucky and are undoubtedly as nearly common in the Mammoth Cave region as elsewhere. In June of 1929 Giovannoli found an old female hoary bat in a back yard at Lexington, Kentucky, with two small young clinging to her body. They had apparently fallen from the branches of a tree overhead, and before the mother could get on the wing were covered by a flower pot, captured, and turned over to Doctor Funkhouser of the University of Kentucky. This seems to be the nearest actual record to the cave region. They are not, so far as we know, cave dwellers, but spend their time hanging head down in dense leafy tree tops during the day and hunting through the forest tops at night. Usually they are easily recognized by their large size and gray color when seen flying before it is too dark, and the

few specimens secured are generally shot at long range with a shot gun and very fine shot.

They breed and spend the summer in Canadian and Transition Zones farther north and should occur in the Mammoth Cave region only on their fall or spring migrations, probably in September or April, but not being cave dwellers they have probably escaped notice.

Their usual hunting grounds are among the tall trees on top of the highest ridges, where with strong, rapid flight they circle and dart among the branches in zigzag lines not easily followed with a shotgun. In a clear place in the forest, however, the skillful collector can usually secure a few specimens at considerable expense of time and ammunition.

The females have four mammae, two on each side of the breast, and there are numerous records of two embryos or young. The young are born late in June and before the end of July are on the wing. Apparently they are carried clinging to the mother until old enough to fly, but they are large at birth, grow rapidly, and begin flying considerably before they are fully grown.

As protectors of our forests these bats are undoubtedly of great value, as their food is gleaned among the tree tops and consists largely of beetles and moths, which are among the special enemies of the trees.

RED BAT: *Nycteris borealis borealis* (Müller)

These beautiful orange-yellow bats are not cave dwellers, but in June of 1909 Arthur H. Howell saw two flying around a black walnut tree in a meadow near the Mammoth Cave hotel and collected one of them. Leonard Giovannoli recognized them flying in early evenings in July near Mammoth Cave and reported one shot by some boys as it hung in the tall weeds on the river bottoms. Others have been collected in various parts of Kentucky and on all sides of the state, indicating a common resident species, but as they rarely enter caves they are not often noticed except by collectors skillful at shooting bats on the wing.

They are usually easy to collect, however, as they come

out early in the evening and fly rather slowly with a soft, even motion. In fact more often than most bats, they come out during the daylight and fly from one tree to another. This may be accounted for by the fact that they usually spend the day hanging head downward in clusters of green leaves of trees and are probably disturbed by the changing angles of sunlight which strikes them and disturb their daylight slumbers. Their eyes are rather large for bats, and when disturbed they seem to have no trouble in finding a better roosting place.

They are a wide-ranging and abundant species, to a great extent migratory in the northern part of their range, but where they spend the winter is not well known, probably in some of our southern forests, where in a mild climate comfortable places to hang up are found in trees, moss, cliffs, or buildings.

In summer they are usually found in open forests, circling around the tree tops and feeding on such flying insects as also inhabit the tree tops and feed upon the foliage.

The females have four mammae well up on the breast and the young are usually two to four. Adult females have been found flying about in search of food with four well-grown young clinging to her body, the combined weight of the young totaling considerably more than the weight of the mother bat.

The young are born in June and develop very rapidly. By the middle of July they are flying about. The mating season begins in late July or early August.

The hibernation period is apparently very irregular as in the vicinity of Washington, D. C., they have been seen flying about as late as November 17, December 15, and January 1, and in the spring as early as March 1.

SILVER-HAIRED BAT: *Lasionycteris noctivagans* (Le Conte)

These medium-sized bats with dark chocolate brown or black fur, tipped with silvery white over the back and less noticeably so on the breast, are readily distinguished from all others by the dark color, the furry upper surface of the tail membranes, and by the rather short black ears

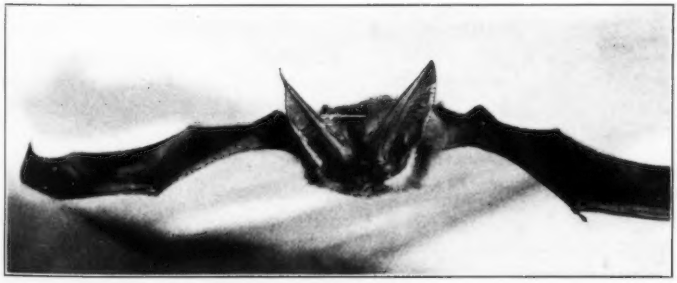
and black membranes. The forearm measures about 42 mm. (1⅝ inches) and the spread of wings is nearly a foot. They are easily recognized on the wing by the wholly black appearance, medium size, and a rather deliberate flight.

They range over much of the continent of North America from northern Canada to Mexico and from the Atlantic to the Pacific, breeding in the northern part of their range and migrating to the southern states for the winter. There are no definite records for the cave region of Kentucky, but records from east and west and north and south of the state would indicate at least a migratory range over all of it.

They are mainly forest dwellers, living in hollow trees, under bark, or in hollow walls of buildings. There seems to be no authentic record of their entering caves, which may account for the lack of information regarding them in this region.

RABBIT-EARED BAT: *Corynorhinus rafinesquii rafinesquii* (Lesson)

These very long-eared bats are of medium size, about a foot in expanse of wings and dark sooty brown in color, and are easily recognizable even on the wing by the long ears projecting forward.



RABBIT-EARED BAT

Fig. 13.—These long-eared bats are described from other caves near Mammoth Cave. They generally occupy rather dry, warm caves.

While at Mammoth Cave Giovannoli was told by a young man living there of what he called *mule-eared bats* found living in another cave farther down the river, possibly Bat Cave. They had been seen in spring and fall of previous seasons, and undoubtedly were of this species.

There seem to be no other records nearer to the Mammoth Cave than at Bowling Green where Prof. Garman records a specimen taken by Miss Sadie Price a few years ago. The type locality of the species is somewhere in western Kentucky where Rafinesque found them more than 100 years ago. The cave region is on the border of the range of the species, which is a regular winter resident of caves and may be expected in some of the dryer and warmer chambers which they seem to prefer. In winter hibernation they hang up singly or in groups with the long ears curled around the sides of the head like rams' horns and would hardly be recognized until they awaken and straighten out their ears.

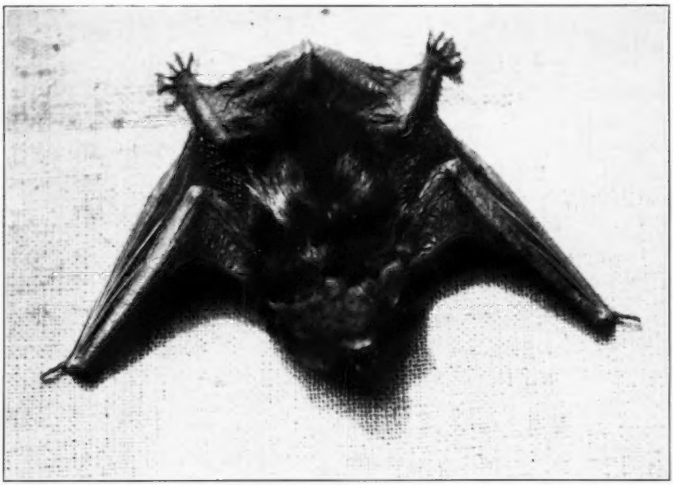
LARGE BROWN BAT: *Eptesicus fuscus fuscus* (Beauvois)

These large dark brown bats are common in summer outside of the caves. Giovannoli collected one specimen near Mammoth Cave Hotel on July 10 and wrote that he could have secured more if he had been a better wing shot as they were abundant any evening. In late September they were still common and many were seen flying over Green River on warm evenings but they are strong, quick crooked flyers and not easily secured on the wing with a shotgun. One was found hanging in Colossal Cavern near the entrance on September 21 and later I found a skeleton in one of the side tunnels of the cave, but no great numbers were found in any of the caves visited.

A few sometimes enter caves and spend the winters there, but generally they find winter quarters in houses or other buildings where they creep into protected attics, under roofs, or into the walls. Often in the coldest winter weather when fires are the hottest they come out inside of houses and are captured or killed. Almost every winter in Washington, D. C., several are brought to me alive during January and February, generally having been found in or around occupied houses or large apartments. They are invariably very fat, with empty

alimentary canal, in every way indicating recent awakening from hibernation. When given cool, dark, moist quarters they quickly become torpid and if undisturbed will remain so for the rest of the winter, awakening with the warm days in April.

To what extent these bats migrate is not known but apparently they choose any satisfactory quarters near at hand, be it house, hollow tree, or cave. Important notes by Miss Althea R. Sherman from McGregor, Iowa, tell of some that made local migrations to winter quarters about October 8, after a sleepy period of 11 days, during which most of the



LARGE BROWN BAT

Fig. 14.—A few of these large brown bats were found in Colossal Cavern but usually they do not gather in great numbers in caves.

days and nights were spent hanging up behind the closed blind of a window. In spring the same species and probably the same individuals returned to the same window about May 13 — (May 2-30). (1929, pp. 321-322.)

The mating season of these bats is generally in August or late July, and the one or two young are born in June of the

following year. They are carried clinging to the body of their mothers, sleeping and nursing under the folded wings during the day and clinging securely to the fur while the parents gather food on the wing until the young are old enough to take to the air and catch their own food.

These large bats are most abundant in forested areas and much of their food is gathered among the tree tops during summer evenings and early mornings. Like other nocturnal animals, they probably do not work all night and Miss Sherman's observations (p. 321) that they were usually in their roosting places at midnight, and sometimes as early as 11 p. m., would indicate a midnight siesta of considerable length. In the early morning twilight they are again active, getting a well-filled stomach to comfort them during the day. The stomachs are large and when filled to the limit with insects represent a full quarter of the total weight of the animal. The stomachs are quickly filled during the evening flight and another hearty meal in the morning (and perhaps still others) account for the destruction of a large number of insects, just how many we cannot tell.

GEORGIA PIPISTRELLE: *Pipistrellus subflavus* (F. Cuvier)

These tiny yellowish brown bats are the smallest of all the small bats of the Mammoth Cave region and one of the very common species, summer and winter. On April 19 I found them hanging in considerable numbers to the roof and walls of the Bat Cave, one of the Carter Cave groups in Carter County, Kentucky, still fully torpid, cold, and apparently lifeless, where they had spent the winter in a state of hibernation. They were scattered about, singly or only two or three close together, but in all there were probably a hundred or more on the walls and ceiling of this one cave, but never with or close to the much more numerous individuals of the larger *Myotis sodalis*.

My thermometer had been left behind but the temperature of the cave was about the same as of other caves that registered 54° or 55° F., and the humidity was approximately 100°. In fact the fur of the bats showed a beady moisture, revealing a slight degree of condensation from the air and indicating the moisture content necessary for any hibernating species.

The guide told me that the bats were less numerous than they were a week before as many had left the cave during a few days of very warm weather, but those found had evidently not yet been aroused from their winter sleep.

When taken in hand they were at first cold and apparently lifeless, but when held for a time and partly warmed they began to show signs of life, slowly moving a wing or leg, and finally in the warm outside air fully awakening and becoming active and angry at being confined in a cloth bag, squeaking and biting their protest. When released they flew away as if they had never been asleep.

Another cave half a mile below the Carter Cave had a few of these little bats but contained mostly the larger *Myotis*.

On April 21, I went through a part of Mammoth Cave from the new entrance but the entrance had been boarded up and only one bat was found inside, away up on the roof where it could not be identified.

In the afternoon of the same day Long Cave was visited, some two or three miles from New Entrance, and among perhaps a thousand other bats a few of these little red-furred fellows were found hanging to the ceiling, less than 100 in all. The temperature was 54° F. and the air saturated with moisture. The bats' fur was damp and beady with condensed moisture and their bodies were as cold as the air, rigid and apparently lifeless. Here they had hung all winter by the well-curved hind claws hooked over rough places in the cave roof. Their eyes were closed but the little short ears were not folded. The wings were folded close down to the sides and the tail over the belly as the little upsidedown bats hung by their heels in their winter sleep.

Those picked off for specimens awoke later when carried in a bag in the warm outside air and loudly protested their captivity. Later those prepared for specimens were found to be still moderately fat though both the stomachs and alimentary canals were entirely empty, and the tiny embryos showed no increase in development during the winter. Evidently the bats had not awakened since hanging up about the first of the previous October, though others may have already left the cave.

The weather outside was warm, with numerous flowers,

young leaves, and abundant insect life, so the awakening of the bats was timely, though the air of the cave is slow in registering any change. In fact, it seems strange that the bats should know when spring has come.

In Dixon Cave, close to the old entrance of Mammoth Cave, on April 22, these little pipistrelles were still hanging in considerable numbers, though not more than a hundred in all, near the back end of the cave where the temperature was still 52° F. There were none in the big room nearer the entrance, where greater numbers of *Myotis* were hanging, and probably many had already aroused and gone out and away to their summer homes. The guide said there had been thousands of bats in the cave during the winter instead of the few hundreds at the time of our visit, but he made no distinction of species.

In Mammoth Cave there are now very few bats even in winter, although before it was so much frequented by people there must have been great numbers to account for the extensive deposits of very old guano.

In Edmonston County there are said to be over 200 known caves, only a few of which are frequented by people, but most of them to a greater or less extent by bats of one species or another.

During the summer of 1929 no bats of this species were collected by Giovannoli until August 21 and 22, when one was taken in Buzzard Cave and one in Crystal Cave, a few miles north of Mammoth Cave. Two others were collected at Mammoth Cave August 31, and on September 24 I found one, almcst torpid, hanging to the roof of the Floyd Collins Crystal Cave in a temperature of 57°, and on September 26 a few were found hanging to the roof of Long Cave with a temperature of 52° and very humid air. These were fully torpid and probably indicated the beginning of the season of hibernation although it was still warm outside with no frosts, abundant insect life, and numerous bats flying in the evenings.

On September 28 I visited Bat Cave, on the north side of Green River, about seven miles below Mammoth Cave, and found a few of these little bats hanging from the roof among a greater number of little brown and sooty bats. The temperature was 56° and the air so moist that the fur of the bats was damp. They were fully torpid, very fat, and with empty

alimentary canals. They had evidently gone in to stay, although large numbers of little bats were seen in the evening catching insects over the river. Evidently these bats were ready for hibernation at any time when a cold spell should cause a scarcity of food and a corresponding lethargy in their systems.

Up to September 30 the weather had been warm and pleasant, with minimum night temperatures of about 64° F., but during the nights of October 1 and 2 the temperature recorded by the U. S. Weather Bureau at Lexington, Kentucky, dropped to 46 degrees, and on October 3 and 4, to 42 degrees, and did not again reach a minimum sufficiently high for bat activity during the month.

The caves were not visited again until November 16, after heavy frosts, when the leaves were off the trees, and apparently all the bats were in for the winter. They were found in considerable numbers in Long Cave, November 16, and Colossal Cave, November 17, probably a hundred in Long Cave and two hundred in Colossal Cave. They were scattered over the walls and roofs of the caves, generally one in a place, somewhat apart from the greater numbers of *Myotis* and in a state of deep torpor from which they aroused very slowly. Generally their fur was wet with condensed moisture, and when the thermometer bulb was pressed against their sides the mercury ran down two degrees, from 52° to 50°. This may be due to the cooling effect of evaporation from the dew-like moisture on their fur, enveloping them as it were in a blanket of cold air.

Those brought to Washington for study were very active in the bags and boxes on the way, but when weighed and carded and put in cages in a dark box they again became fully torpid in one night in a temperature of 52°, and remained torpid up to early in March.

In the Mammoth Cave region these little bats are evidently in part migratory. Their scarcity during midsummer would merely indicate that they gather in greater numbers at the caves during late September and early October, ready to go into winter quarters at short notice, but how far they come or where they go in spring will not be fully known until large

numbers have been marked and their actual migration routes established.

From the present rather superficial observations the period of hibernation appears to extend from about October 1 to April 15 of the following spring—about six and a half months. This of course varies somewhat with different years and also in different caves.

Evening Bat; Rafinesque Bat: *Nycticeius humeralis* (Rafinesque)

One of these little dark brown southern bats was shot by Leonard Giovannoli at the old entrance of Mammoth Cave on July 25, 1929. It was an immature male in the dark sooty pelage of the young, indicating an actual breeding record for the locality. Whether this was one of the bats living in the cave could not be told as it was just one of the small species flying about the entrance.

Another was collected by Arthur H. Howell near the Green River below Mammoth Cave early in July, 1909, and three were taken at Hickman, Kentucky, in July, 1892, by George A. Coleman.

This is about the northern edge of the breeding range of the species, which is largely Lower Austral in distribution, though scattered records of occurrence reach as far north as Washington, D. C., Virginia, and Pennsylvania. Over the southern states from Texas to Georgia these are among the commonest bats.

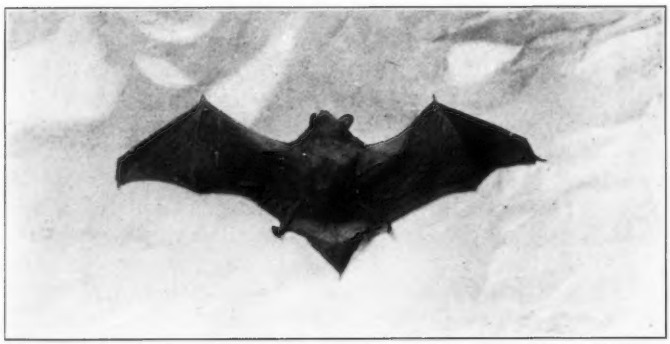
Evening bats are found in a variety of locations, along streams and ponds, about buildings, and in the open forest. At Bay St. Louis, Mississippi, I found about twenty roosting during the day under loose bark near the top of a dead pine tree. At Mer Rouge, Louisiana, they were the most abundant small bat flying around the farmhouses in the evenings, and a number of specimens were collected. So far as I know, they have not been collected in caves, and in their southern habitat trees and old buildings may furnish protection enough for their winter quarters. In southern Florida they have been found in large numbers occupying hollow trees in midwinter.

The females collected for specimens in May and June

usually contain two foetuses each, and the mammae are arranged in only one pair on the breasts, as with most other bats.

LITTLE BROWN BAT: *Myotis lucifugus* (Le Conte)

These little brown bats, bright hazel brown above and paler brown below, are apparently one of the commonest of the Mammoth Cave region of Kentucky, both in summer and winter. Only by careful study and comparison can they be distinguished from the four other distinct species of the same genus in this region and from the very different but similar appearing *Nycticeius humeralis* which also occurs here. They are merely one of the six species of small brown bats that the common name might fit in this one locality but that are wholly indistinguishable on the wing.



LITTLE BROWN BAT

Fig. 15.—These little brown bats are one of the most abundant of the bats hanging up for winter hibernation in the Kentucky caves.

In the open they are seen flying rapidly about on mild evenings, catching insects on the wing, or skimming over the surface of the water to drink from the river or the ponds.

On April 21 and 22 they were found in small numbers in Long and Dixon Caves, and in late September in Colossal and Bat Caves, and on November 15 and 16 in great abundance in Colossal, Long, and Dixon Caves. Apparently they entered

the caves in greater numbers about the first of October, when the weather in the general region dropped to a minimum of 42 to 46 degrees at night. Before that it had not been below 60 or 64 degrees and the bats had entered the caves only in small numbers.

On November 15 and 16 I estimated 1,000 bats in Dixon Cave, 2,000 or 3,000 in Long Cave, and about 5,000 in Colossal Cave, probably half of which were of this species.

They were hanging heads down from the roof mainly, but occasionally a few on the side walls of the cave rooms. In some cases there were bunches of a hundred or more packed close together but never hanging from each other "like bees" as is often reported. In circular bunches only the heads and ears showed below except those around the outer edges. Some were in small bunches of two or three to a dozen and others in long rows along the edges of cracks or on lines of rough surface. A few were scattered singly. In some cases the little brown bat and little sooty bat were found in mixed bunches, but generally each species of bat keeps by itself.

The temperature of these bat caves in April and September was generally 54°, 55°, or 56° Fahrenheit, and in the middle of November it varied from 52° to 54°. In all of the caves the humidity must have been close to the saturation point as the fur of the bats was generally moist and often in single individuals fairly wet with fine silvery drops of dew.

The body temperature of the bats when dry was generally the same as that of the air but when the thermometer bulb was pressed against the back of one that was wet the mercury fell from 52° to 50° in a few seconds.

All of the bats were very fat, the average weight being about 9 grams, of which about 3 grams was fatty tissue. The alimentary canals were entirely empty but the bladders were well filled with water.

Evidently the times of entering the caves for the winter sleep and leaving for the summer activity are not fixed dates or wholly dependent upon the weather outside, but vary with the many factors involved, temperature, moisture, food supply, bodily condition, age, sex, amount of fat accumulated, character of summer roosts, and probably social instincts beyond our understanding.

Much light has recently been thrown on the habits of these bats by the long, careful studies of Miss Althea R. Sherman, of McGregor, Iowa, especially on the time and manner of leaving their summer roosting places in the fall and reappearing in spring. Their disappearance in the fall varied there from about the middle of September to the middle of October and usually followed a period of some two weeks of lethargy in which only occasional flights were made. This lethargic period is evidently the necessary preparation for hibernation, a time of fasting while the alimentary canal is being thoroughly emptied, and before winter sleep is safe.

In my experiments with bats I find that when they have been given a cold place for hibernation on full stomachs they have died in a few days. A week or more of partial activity seems a necessary preparation for hibernation in most if not all mammals that spend much time in a state of complete torpor. There are also important physiological changes or adjustments in the body of hibernating animals not fully understood.

Embryos in the November females were so small as to be scarcely perceptible and in many cases could not be found by a cursory examination. The mating season of these bats is in August and the young are born in June of the following year. Usually there is little advance in the development of embryos until after the females have left their winter quarters in April. Then the development is rapid and the one large embryo is far advanced at time of birth.

The young is carried clinging to the body of the mother until old enough to fly and capture its own food of flying insects.

The food of these bats is shown by the stomach contents and pellets of excrement to be entirely of insects, probably all of flying forms such as beetles, moths, flies, and a great variety of unrecognized kinds. They are so thoroughly masticated as to leave little evidence of the species except under the microscope, where the hard parts of certain insects are recognizable and the vast number of unmistakable scales of moths are found to retain their perfect form.

The economic importance of bats in general can be only

guessed at until an exhaustive study of their food material under varying conditions has been made.

LITTLE SOOTY BAT: *Myotis sodalis* Miller

These little sooty brown or blackish bats are about the size and general proportions of the little brown bats but are readily distinguished by darker colors with little or no trace of brown. The fur is shorter and more dense and lacks the long glossy

BATS HUNG UP FOR WINTER IN BAT HALL, COLOSSAL CAVERN

Fig. 16.—These little upsidedown bats hang all winter by their hooked hind claws, wholly torpid, cold, and motionless from the first of October until the warm days of April or May.

back hairs. The upperparts are almost black, the lowerparts very dark gray with a purplish tinge, the ears and membranes dull black.

Next to the little brown bats, they are apparently the most numerous of any in the Kentucky cave region, being found in large numbers in the Carter Caves, Dixon Cave, Colossal Cave, Long Cave, and Bat Cave. Very few bats were seen or collected in Mammoth Cave, but there is ample evidence in the old guano deposits that this was once a great resort for them. In the early history of the cave bats were reported there by thousands. At present the constant use of the cave by visitors with lights, smoke, and noise keeps away these interesting and useful animals and sends them to neighboring and more quiet caves.

In Dixon Cave on April 22, 1929, they were hanging to the roof near the back of the cavern in bunches or rows of a dozen to fifty together or scattered out by twos and threes over the ceiling, fully torpid still in the moist cave air at 52° F. But there were only a few hundreds in all, while on November 15 there were at least 1,000 bats hanging on the ceiling, evidently gathered for the winter. A light load of small shot fired into one of the bunches of bats far overhead brought down three *sodalis* and three *lucifugus*, and in many other places these two species were closely associated in the caves. On July 6 and 15 Giovannoli collected several practically full-grown young of the year, showing this to be one of their breeding as well as wintering caves.

In Long Cave on November 15 there were some two or three thousand bats hanging from the roof, largely little brown bats but including many of these dark-colored individuals. The air of the cave was 54° F., and the moisture near the saturation point. The fur of many of the bats was silvery with condensed moisture and most of those examined closely were cold and fully torpid. Still a few, probably fresh arrivals, were active and flying from place to place when disturbed. Others began to tremble when the strong lights were held on them and in focusing the camera on bunches where it was necessary to keep the light on them for several minutes, the vibrations were noticeably increased and if long continued might well result in partial or complete awakening. When

taken in hand these vibrating bats could be felt trembling violently all over, apparently a voluntary or involuntary reaction to disturbance. Held in the warm hands for a few minutes they soon began to move slowly, then more actively, until fully aroused and able to fly.

When gathered cold and stiff from the roofs of the caves and put in cloth bags, a dozen or more together, they rapidly warmed up and in half an hour were a squirming, squeaking mass of very warm, angry, and excited bats. Many were taken outside where they could be sorted by species in a good light, and those not needed for specimens were allowed to fly away in the mild outdoor air, their natural instincts being trusted to guide them back to their favorite caves when darkness came to render their surroundings recognizable. At first they flew away among the tree tops or alighted on houses or any support that afforded temporary rest and shelter. Those brought home to Washington alive for study were necessarily kept in cloth bags for a couple of days until I was ready to start, and then in a box for two days more on the train, and when weighed on arrival before being placed in the boxes for return to hibernation they had lost noticeably in weight, about two grams each, or from nine grams to seven. Still they were well supplied with fat, and when placed in a room with a temperature of about 54° they were fully torpid next morning and remained so up to early in March.

So far as known these little dark sooty bats have no peculiar habits to distinguish them from the little brown bats. Only recently, in 1928, were their very distinct specific characters recognized by Gerrit S. Miller and a name given to them. The type of the species was selected from Wyandotte Cave, Indiana, but other specimens were listed from Mammoth Cave, Kentucky, and from Alabama, Arkansas, Illinois, Michigan, Pennsylvania, Vermont, North Carolina, and Tennessee. Most of the specimens have been taken in caves during hibernation and very little else is known of them.

GRAY BAT: *Myotis grisescens* Howell

These little grayish brown bats are not so easily distinguished from the little brown bats by color as they are by the very long hind feet, entirely free from the edge of the tail

membranes. Besides being grayer in color, they are slightly larger than the little brown bat, with forearms measuring 41 mm., hind foot 11 or 12, and ear 14 mm. They evidently belong to the *Myotis velifer* group, merely extending its range into the cave country of the Middle Eastern States.

There are specimens from Tennessee, Alabama, Arkansas, Missouri, southern Illinois, and Kentucky, mostly from caves or the near vicinity of caves.

The one specimen from the Mammoth Cave region was a male, taken by Leonard Giovannoli in Dixon Cave on July 6, 1929. It was not recognized at the time and no notes were made as to its location or habits. Apparently they inhabit the caves all summer, coming out in the evening and gathering their food in the surrounding country and returning before daylight. Whether they winter in the same caves is not definitely known as the only specimens have been taken in summer, mainly in June and July. In the cave where the type was

Fig. 17.—Bats hanging on walls of Little Bat Avenue in Mammoth Cave.

taken in southeastern Tennessee, A. H. Howell reported hundreds of them hanging in a great mass from the roof of the cave on August 31, 1903. In July, 1892, I collected specimens deep down in the great Marble Cave, of Missouri, and others at the entrance as they came out in the evening. At that time they were identified as *Myotis velifer*, the cave bat of Mexico and the southwestern United States, which with its subspecies *evotis* and the present form are all cave dwellers.

SHARP-EARED BAT: *Myotis keenii septentrionalis* (Trouessart)

[Long known as Say's Bat, *Myotis subulatus subulatus* (Say)]

These small light brown bats can best be recognized by the long, narrow pointed ears that when pressed forward reach an eighth of an inch beyond the tip of the nose. Otherwise in size and proportions as well as color they are very similar to the little brown bat, *Myotis lucifugus*.

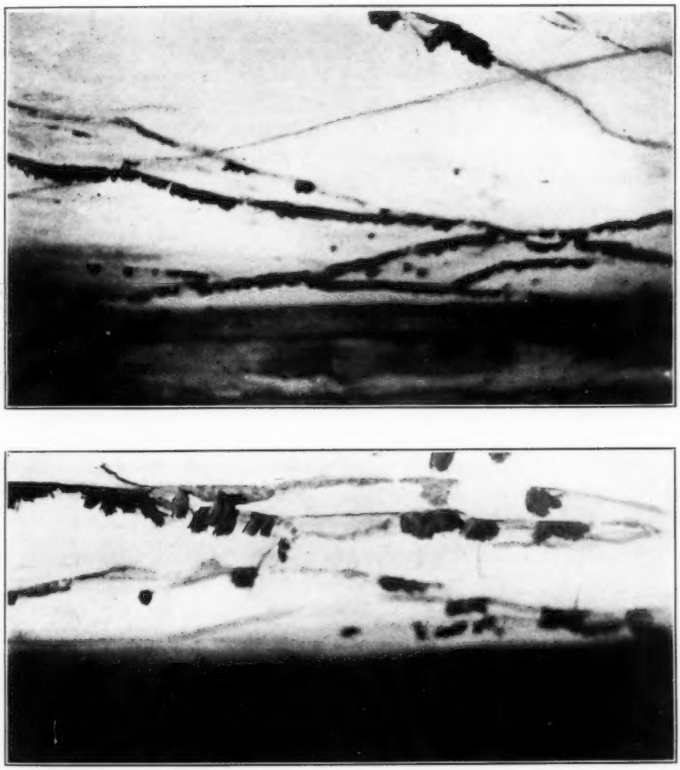
They have a wide range over the eastern United States from the western part of the Dakotas to Maine and Nova Scotia and from southern Canada to northern Georgia. They are generally less abundant than the little brown bat and less given to gathering in caves although with approximately the same range and same general habits. Their wide distribution shows that they are not dependent upon caves in summer and probably not entirely in winter unless they make long migrations to reach them.

On July 21, 1929, Leonard Giovannoli found one of these bats hanging up in a house near the Mammoth Cave Hotel. It was a male and the only specimen secured there. On November 16 I found one among a lot of bats taken from the roof of Colossal Cavern a few miles from Mammoth Cave. This was a female and had evidently hung up for the long winter's sleep. As they are not easily recognized in the dim light of the caves they are probably much more common among thousands of small bats hanging up than is indicated by the few specimens collected.

In habits no distinctive characteristics have been recognized in this species, but this does not signify anything beyond the fact of our ignorance of this group.

LEAST BROWN BAT: *Myotis subulatus leibii* (Audubon and Bachman)

This tiny bat may be recognized among all the other eastern bats by its very small size, the forearm measuring only about 32 mm., and by its dark brown fur and black nose and



LITTLE BROWN AND SOOTY BATS

Fig. 18.—These bats, photographed April 21, 1929, in the Bat Room of Long Cave, had been there all winter and were just beginning to become active again. They cling by their hooked hind claws to the rough edges of cracks and seams in the rock of the cave.

face. The back is dark hazel brown, belly slightly paler brown, ears and membranes blackish. The ears reach only to the tip of the nose. On August 22, Giovannoli collected one of these bats at Mammoth Cave and another at Crystal Cave. These were flying about in the evening.

On November 16 a few were found in Colossal Cave hanging torpid to the walls and ceiling, and one specimen was saved and another kept alive for study. A few others escaped from the bag before reaching Washington. The species could be recognized only among the few that were close to me and may have been well represented among those higher up and farther away. They are about the size of the little yellow *Pipistrellus subflavus* and on the wing it was usually impossible to distinguish between the two among the great numbers of tiny bats seen flying over the river on warm evenings.

The known range of the least brown bat covers only a few other localities: Hickman Cave, Kentucky; White Sulphur Springs, West Virginia; Plummers Island in the Potomac just above Washington, D. C.; Sing Sing, New York; and Brandon and Proctor, Vermont; but they evidently belong to the *subulatus* group extending across the continent, and including the forms of *subulatus*, *melanorhinus*, and *leibii*.

Little is known of the habits of this little bat to distinguish it from other species but undoubtedly it does fill a niche in bat economy not occupied by any of the others. Who knows but it may be the special guardian of some of our choicest flowers, shrubs, or trees.

III.—SOME OF THE BIRDS OF THE MAMMOTH CAVE REGION

FLORENCE MERRIAM BAILEY

"Wild Life in Kentucky," by William Delbert Funkhouser (1925), one of the volumes of the State Geological Survey, includes the birds found about Mammoth Cave, but it may be of interest to visitors to know some of the many birds recorded from the state that are to be found about the caves during the tourist season. Spring visitors may be fortunate enough to see some of the spring migrants on the way from their winter homes in the south to their nesting grounds in the north while, on the other hand, fall visitors may have the pleasure of seeing some of the fall migrants on the way from their nesting grounds in the north to their winter resting grounds in the south. But most of the birds seen by the tourist will be those that actually nest in the region.

The section where the birds included in this list were found during the season of 1929 by Leonard Giovannoli, Mr. Bailey, and myself, covers the vicinity of Mammoth Cave; the gulch leading down from its main entrance to Green River, with a few species noted on Green River; the vicinity of the "New Entrance" to Mammoth Cave, and Long, Great Onyx, Dixon, Colossal, Mammoth Onyx, and Hidden River Caves; and Cave City.

Many of the birds recorded in Wild Life in Kentucky are conspicuously absent from sections adjoining the Mammoth Cave country. Notable in this class are the hawks, a large number of which are listed by Funkhouser. As Giovannoli stated, when, after two months' intensive work in the region he could report seeing only three hawks, each on one occasion, "the farmers have evidently waged a very successful war on all hawks in this section." This ignorance of the value of our birds of prey is especially unfortunate in a country where all possible help is needed to

protect the scant crops from the ravages of rodents and insects.

The nomenclature used in this list is that of the 1931 edition of the Check-List of North American Birds. In this edition, in many cases the names differ from those commonly used previously. But the retention of the numbers used after the names in former check-lists and other published lists will serve to correlate the unfamiliar names.

GREAT BLUE HERON: *Ardea herodias herodias* Linnaeus [194.]

A summer resident in Kentucky. One of the great blues, the largest of our long-legged wading herons, recorded by Benedict J. Blincoe as a summer resident of Nelson County, was seen on September 28 by Mr. Bailey, flying around over Green River about five miles below the Mammoth Cave ferry. A boy on the boat, who called it a blue crane, said he had seen it the day before on the river bank. Fortunate, indeed, it is that any of these great birds are left in a land of such ready guns. Perhaps we owe their continued presence to their "extraordinary keenness of vision and their exceeding wariness."

Although dignified and solitary fishermen most of the year, the herons nest in colonies, or as Arthur C. Bent expresses it, in closely congested communities, varying in size from a few pairs to several score or even hundreds.

A graphic description of one of these heron villages is given by the indefatigable William L. Finley in American Birds, where he tells of a heronry of about seven hundred nests of the great blues and the black-crowned among which he camped all night to get early morning photographs from a tree top.

Photographs of the Florida great blue, in "Camps and Cruises," taken at the nest by Frank M. Chapman, illustrate a peculiar method of feeding the young. Instead of the usual regurgitation by the parent into the open bill of the nestling, the bill of the parent was seized crosswise by the bill of a young one, as with a pair of shears, and was then forced down into the nest "where more or less digested fish was disgorged, of which all the young at once

partook." When a fish too large for the nestlings was disgorged, the parent reswallowed it and returned to a perch near the nest, where it waited for digestion to properly prepare the meal.

See Pearson, T. G., Herons of the United States, Bul. 5, Nat. Assoc. Audubon Soc.

[AMERICAN EGRET: *Casmerodius albus egretta* (Gmelin)]
[196.]*

The wholly white large egret, with yellow bill, black legs and feet, and long white aigrettes reaching far beyond its tail, used to breed as far north as New Jersey and Wisconsin, and is given by Mr. Funkhouser as formerly a common migrant in Kentucky, with records in Ballard and Nelson Counties on both sides of the cave region, so it may have crossed that. But it was slaughtered for its aigrettes from the time of Audubon and its numbers so depleted that extermination was feared. Of the plume trade, Bent, in his "Life Histories," says, "The destruction wrought by the plume hunters has been most cruel and wasteful; as the plumes are at the best during the breeding season, the birds were shot in their nesting rookeries, leaving the eggs to rot or the young to starve in the nests. No thought was had for the future and whole rookeries were systematically annihilated. . . . Fortunately . . . these conditions have now largely changed and plume hunting has become a thing of the past in most of the regions where it was formerly practiced. The vigorous educational and legislative campaign of the National Association of Audubon Societies, and other organizations and individuals interested in bird protection, have created a world-wide sentiment against it and have resulted in adequate laws to prevent it. Many colonies have been successfully protected."

After the breeding season the egrets, like other herons, wander north, and between July and September should be looked for as, under the present favorable conditions for

* In accordance with custom, species of doubtful occurrence in the region are included in brackets.

their restoration, it is possible that one of the beautiful white flocks may again be seen winging its way through the blue sky.

One of the Florida colonies is described and illustrated with photographs by Dr. Chapman in "Camps and Cruises."

[SNOWY EGRET: *Egretta thula thula* (Molina) (197.)]

The small snowy egret listed by Funkhouser was recorded by C. W. Beckham from Nelson County in 1880. For its short recurved plumes, known in the millinery trade as cross aigrettes, Bent tells us it "was slaughtered in much greater numbers than its larger relative, because it was originally much more numerous and more widely distributed, because it was much less shy and so more easily killed and because its short and delicate plumes were more in demand than the larger, stiffer plumes of the egret. For these three reasons it suffered far more at the hands of the plume hunters and came much nearer being exterminated. But the same timely efforts stopped the slaughter before it was too late and saved the species, which is now increasing in protected localities."

As it is now recorded from North Carolina, it is possible that its post-breeding wanderings may lead it across the cave region of Kentucky.

See Dutcher, William, Special Leaflet 21, Nat. Assoc. Audubon Soc.

LITTLE BLUE HERON: *Florida caerulea caerulea* (Linnaeus) [200.]

It is well to bear in mind the points of difference between the white plumage of the young little blue heron and that of the snowy egret.* For while the millinery trade in aigrettes once threatened the extermination of both egrets, the timely educational and legislative campaign of the National Association of Audubon Societies and other organizations has brought them back in protected

* Pearson, T. G., Herons of the United States, Bul. 5, Plate 1 (colored), Nat. Assoc. Audubon Soc.

localities, and on their northward post-breeding wanderings they may well cross the cave region of Kentucky, in which case they should be recognized and guarded in every possible way. About half the size of the great blue and approximately the size of the snowy egret, the little blue in its white first fall plumage might suggest the snowy, except that it lacks the recurved aigrettes of the snowy, its wing quills are tipped with slaty, and its legs and feet are uniform dull greenish, while the legs of the snowy are blackish and the feet a sharply contrasting yellow. The pure white of the little blue's first plumage usually begins to be streaked and splashed with blue during the first winter and before long all the white is gone and it fully merits the name of little blue heron.

One was seen in July by Giovannoli at Mammoth Cave, and at Bowling Green, Gordon Wilson (1922, p. 234; 1929, p. 182) found it "a very rare summer resident, April 8-September 21." He has found a few in the white plumage in the fall and once saw ten on Barren River.

In Fulton County, L. Otley Pindar found the little blue fairly common in summer. Like other herons, it nests in colonies and its courtship, greeting ceremonies, nest-relief ceremonies, emotional displays, and flight maneuvers, we are told, are similar to those of the other small southern herons. Like them the white young, especially, often wander far north of the breeding range in summer and fall, sometimes going as far as Canada.

EASTERN GREEN HERON: *Butorides virescens virescens* (Linnaeus) [201.]

The handsome green heron with its long reddish brown neck and greenish black crest and wings,* reported by Gordon Wilson as a fairly common summer resident of Bowling Green, was seen by Mr. Giovannoli twice during the summer in the Mammoth Cave region. One was also seen by Mr. Bailey the last of September on Green River, about six miles below the Mammoth Cave ferry. When

* Pearson, T. G., Herons of the United States, Bul. 5, Plate 4 (colored), Nat. Assoc. Audubon Soc.

discovered it was on the river bank close to the rowboat. Startled, it ran along a little ways, then flew; and when the boat caught up to it, again ran and flew, recalling its name—"fly-up-the-creek." The country boys who were paddling and thought it a snipe wanted to shoot it but were finally persuaded to let it live. There is no open season on any of the herons in Kentucky, but need for educational work is urgent if the legally protected birds are to be saved.

From Handbook of Western Birds. L. A. Fuertes.
Fig. 19.—Green Heron.

Although rather solitary in habit, the green heron nests both singly and in colonies, and while as a rule it does not nest with other kinds of herons, it is occasionally found in the same grove with the little blue and other members of the family.

Of the vocal courtship performances of the various herons little seems to be known, but Dr. Charles W. Townsend has made an interesting study of what he calls the green heron's song, though he describes it as "very peculiar" and "most unbirdlike," coming apparently from the depths of his anatomy, like deep breathing or low groans. Standing erect on a perch, at intervals he raises his head and neck, opens wide his bill and emits his *ow-ch*, "sometimes as often as ten times in a quarter of a minute."

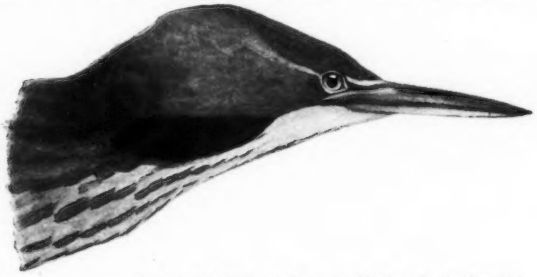
The story of the green heron's life, from the nest up, illustrated by photographs, was told by Dr. A. A. Allen in 1929 in Bird-Lore's School Department.

AMERICAN BITTERN: *Botaurus lentiginosus* (Montagu) [190.]

A migrant in Kentucky. One of the long-billed brown-streaked bitterns was seen on April 21 by Mr. Bailey near the New Entrance to Mammoth Cave, probably on the way to northern breeding grounds. Could he be detained for the breeding season by some tempting marsh, it would be rare good fortune for his human neighbors. For the "Stake Driver" is

not only compelling when his stake driving resounds over the marshes, and amusing when he points his bill heavenward to pose like an upright reed, but fascinating when he makes love with a display of his beautiful snowy nuptial plumes.

Kentucky is to be congratulated that it has no open season on this quaint bird with his unique and entertaining habits.



From Handbook of Western Birds. L. A. Fuertes.

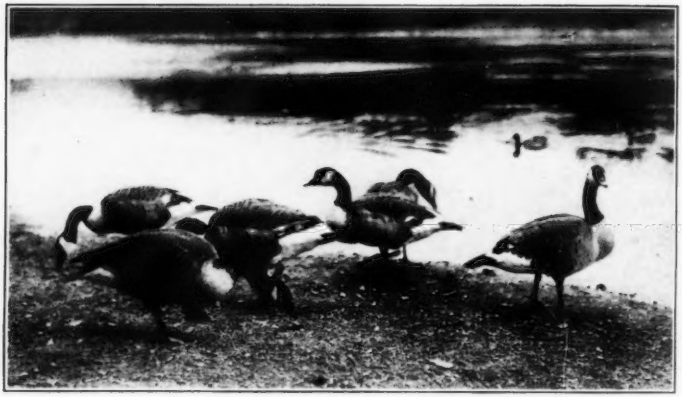
Fig. 20.—Bittern.

See Brewster, William, The Auk, vol. 28, pp. 90-100, 1911 (nuptial plumes); Chapin, J. P., The Auk, vol. 39, pp. 196-202, 1922 (booming); Fargo, W. G., The Auk, vol. 45, pp. 203-204, 1928 (courtship display); Pearson, T. G., Educational Leaflet 130, Nat. Assoc. Audubon Soc.; Thayer, G. H., Concealing coloration in the animal kingdom, pp. 56-57, 1909; Torrey, Bradford, Everyday birds, pp. 69-81, 1901 (posing).

COMMON CANADA GOOSE: *Branta canadensis canadensis* (Linnaeus) [172.]

The familiar honkers or Canada geese are found occasionally on Green River or on the ponds in the Mammoth Cave region in winter, Mr. Bailey was told, and they were recorded by L. Otley Pindar in 1889 from Fulton County as rare summer residents. But as a rule they are seen in Kentucky only in passing, when their V-shaped migrating flocks and their loud stirring honking seem to tell of the northern breeding grounds from which they come and to which they will return.

One interesting case Mr. Funkhouser records, however, where the presence of some domesticated wild geese attracted a migrating flock to the farm of W. A. Huggins, not far from Glascow. During a term of winters they stopped in increasing numbers until in "the extremely cold



From Biological Survey.

Fig. 21.—Canada Goose.

winter of 1917, over three hundred of these beautiful birds were fed and protected."

Perhaps if similar delightful offers of true Kentucky hospitality were made at other points along their migration route, the pleasure experienced by the Huggins family might be shared by more bird lovers.

TURKEY VULTURE: *Cathartes aura septentrionalis* Wied [325.]

The large familiar form of the turkey vulture is often noticed in the cave region sailing slowly around high enough for the gray border of its wing linings to be distinguished, even when far too high for its bare reddish head to be seen.

As it sails smoothly around, changing its direction by a tilt of the outspread wings, its beak is pointed down, for this useful scavenger has need to scan the ground below for carrion. How it discovers the carrion, whether by sight or smell, has long been a moot question, but some enlightening experiments made by John B. Lewis seem to indicate that in cold weather, when little odor is thrown off, sight is the vulture's chief means of locating food, but in warm weather,

when odor is strong, it has no difficulty in locating the carrion by scent.

Summarizing his experiments, Mr. Lewis says, "a dead hen lay in an open field concealed from sight for four weeks [in January and February] without attracting any apparent attention from the vultures that sailed across the sky every day. The carcass was then exposed to view. . . and in less than ten minutes four vultures alighted within twenty feet of it." On the other hand, in warm weather—in July—the carcass of a freshly killed opossum was left in a box in an open field. The next day one vulture lit near it and the second day several circled over it. On the third day, when the box was removed, eighteen vultures came sailing low over it, one alighting and eating some of it. On the fourth day, sixteen vultures, about half of which were blacks, "gathered about the carcass and completely cleaned up whatever may have remained of it."

A previous experiment made by Alexander H. Leighton, narrated in the Auk, resulted in attracting a number of vultures to a stuffed deer, but decayed meat brought none.

Studies of the nests of the vultures are always interesting. One of a cave nest with white downy young has been made by Paul G. Howes, reported in Bird-Lore, and one of a tree nest that was under observation for five years by Russell M. Kempton is told with interesting detail in the Wilson Bulletin. The pair arrived from the south about six weeks before they made the season's nest and during the cold wet spring used the old nest hollow to roost in. Here Kempton found them several times in the daylight "standing with heads together." The nest was prepared "by pulling at the dry rotten wood on the side walls of the cavity with their beaks. When a large piece came loose the female would hold it down with one foot and tear it into small bits, which she spread about on the floor, where the eggs were to be deposited. The interested male bird was a hindrance in nest making, and every now and then the female placed her head under his breast and pushed him out of the way. Once he tumbled out of the tree. However, undaunted, he clambered back, keeping his head down so that his mate

could not repeat her attack, and more in the way than before."

See Pearson, T. G., Educational Leaflet 100, Nat. Assoc. Audubon Soc.

BLACK VULTURE: *Coragyps atratus atratus* (Meyer) [326.]

In the cooler parts of its United States range, a glance at a soaring vulture is enough to name it the turkey vulture, but in the warmer parts, especially along the southern seacoast, a second look may prove it to be the short-tailed, black-headed or black vulture, which ranges up from the tropics. The two birds are often seen together in the cave region although, at this latitude, the black, as Mr. Giovannoli says, "is apparently out numbered two to one." *

A single bird that I discovered in the sky above Mammoth Onyx Cave was soaring around so high that field glasses were necessary to distinguish its earmarks. The shortness of its tail—actually three inches shorter than that of the turkey vulture—was its most diagnostic character, although in build and pose it looked oddly different from the more familiar bird.

As I stood gazing up at the solitary, diminished figure, it circled around much too high for any practical purpose, it would seem. Could even a carrion feeder know moments of exaltation, in rising into the blue dome?

As its black speck disappeared from view I was abruptly recalled to earth by the cawing of a matter-of-fact crow and a passing blue jay.

An unusual flight of black vultures near Beardstown in Nelson County was witnessed by Benedict Blincoe on March 19, 1921. They were flying rather high over the farm and numbered "not less than ninety-two individuals, a number by far exceeding the total number of these birds recorded in any single year during a period of observation since 1911. The flock presented a beautiful appearance as the birds soared in a spiral column, each bird beating, intermittently, a few short wing strokes. At times the whole flock in a long train coursed

* An illuminating diagram of soaring vultures, hawks, and eagles, seen from below, is given by Forbush, in Birds of Massachusetts and other New England States, vol. 2, plate 38, 1927.

across country. . . . in an orderly manner suggesting the movement of a flock of water fowl."

EASTERN PIGEON HAWK: *Falco columbarius columbarius* Linnaeus [357.]

One record of the small slaty blue pigeon hawk is given by Miss S. F. Price from Bowling Green and Dr. Pindar speaks of it as a "rare winter habitant" of Fulton County. Our only record of the little falcon was one seen on September 19 by Mr. Bailey at Mammoth Cave.

Glancing out of the hotel window when busy preparing specimens of bats, he saw one fly down into the hotel yard and catch a bird. Flying up with it in its claws the little hawk passed so close to the window that its dark color, short stout form, and short tail were seen distinctly, though the crumpled bird in its claws could not be recognized. In any case, as the freebooter carried off its victim, it was pursued by one of the birds left behind, with loud remonstrating cries.

EASTERN SPARROW HAWK: *Falco sparverius sparverius* Linnaeus [360.]

The handsome reddish brown and blue sparrow hawk, or grasshopper hawk as he is more appropriately called, given by Wilson as a fairly common resident of Bowling Green, was seen by Giovannoli only once during the summer, when "three were noted together."

In his paper on the Raptores of Nelson County, Blincoe said that although a telephone pole is the sparrow hawk's favorite lookout point, it is "often observed about the cornshocks at gathering time, in search of mice. In severe weather it often takes shelter in outbuildings."

From Biological Survey. J. L. Ridgway.

Fig. 22.—Sparrow Hawk.

If this most useful little hawk has come under the ban from the general uninformed feeling against hawks or the feeling on the part of the boy with a gun that all birds are legitimate targets, it is most unfortunate. By its record its food in summer, when insects are to be had, is chiefly insects; in winter chiefly mice. Of nearly 300 stomachs examined, Preble states in Nature Magazine, 244 contained insects (mainly grasshoppers and crickets) and also spiders; 54, birds; 89, mice; 12, other small mammals; 12, reptiles and amphibians. Only one game bird was found and no poultry. Insects that injure corn have also been found.

The sparrow hawk is an important ally of the farmer. When it is seen about farm buildings it is probably looking for one of his enemies, the house mice, many of which are caught about granaries and storehouses. Instead of allowing it to be shot the farmer should, as Leon A. Hausman wisely advocates, encourage it to nest in the vicinity of the farm, which can be done by providing nesting boxes similar to those used for flickers.

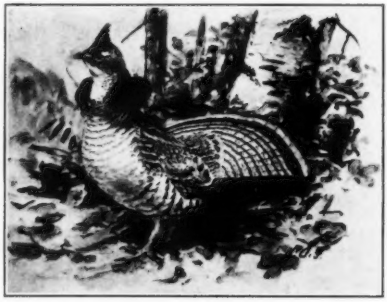
In a lumbering region, where forest fires were common, a fortunate ornithological observer, Arlie W. Shorger, once found as many as twenty opportunist sparrow hawks at one fire, "in spite of the great heat and intense black smoke," catching insects, reptiles, and small rodents as they were driven out of the woods by the flames, often pursuing their prey in smoke so thick that they were lost sight of.

Beside being of economic importance, this handsome, unsuspicious little hawk, when not driven away, is one of the pleasures of the roadside, often perching on a fence post or catching the eye of the passer-by as it hovers in midair looking for its prey on the ground below. Its cry of *killy, killy, killy* is pleasantly associated with quiet fields in the open country.

Eastern Ruffed Grouse: *Bonasa umbellus umbellus* (Linnaeus) [300.]

As the ruffed grouse is a bird of the shaded forest, it is rarely seen except by naturalists and hunters, and as Funkhouser says, "its wonderful rolling drum-beat . . . is now seldom heard in Kentucky . . . as the bird has almost been ex-

terminated by hunters." Its decrease since the original settlement of the country, as has been pointed out, has had many contributing causes such as the destruction of the forest, the use of woodlands for grazing, and the ravages of forest fires. Moreover, it has periodical seasons of decrease due to complex general conditions and is itself subject to parasites, both internal and external, and to a variety of contagious diseases. For all of which reasons, and in consideration of the fact that it is one of the most notable of American birds, it should be generally protected by closed seasons and guarded with the utmost care.



From Biological Survey.

Fig. 23.—Ruffed Grouse.

None of the grouse were seen or heard in the cave region by any of us in 1929, but Giovannoli was told that a few are still to be found.

The best known habit of the grouse—its drumming—has for many years been under discussion from many angles. How does he do it? Does he beat his breast or his drumming log, or does he clap his wings together before or behind? Some of the older ornithologists, notably C. Hart Merriam and William Brewster, by painstaking observation long since solved the problem to their own satisfaction, and numerous "still" photographs of the drummer have been taken, but it has remained for Arthur A. Allen to convince the public by moving pictures of the actual drumming bird. These show the cock on his drumming log with shoulder ruffs erected until they suggest a black tippet closely encircling his neck, first walking slowly down his log and then going through the whole process of drumming. The wings, raised and drawn well back, are brought forward without touching the body, *beating only the air* as they produce their well-known *thump, thump, thump*, followed by the rapid "drumming roll."

The story of the life of the ruffed grouse, illustrated by photographs, was told by Dr. Allen in 1927 in Bird-Lore's School Department, and a notable account of grouse observed in Maine was given by Brewster in 1925.

The interesting winter habit of the grouse of "plunging into a snowdrift from the wing and spending the night under the shelter of the snow," Glover M. Allen (1925, p. 272) says "often proves fatal if a light rain falls and a freeze crusts over the snow so that the birds cannot break forth next morning."

See Grinnell, George Bird, Educational Leaflet 63, Nat. Assoc. Audubon Soc.

EASTERN BOB-WHITE: *Colinus virginianus virginianus* (Linnaeus) [289.]

The visitor to the caves who has not time to go far afield to look for birds may perhaps be assured of the presence of this delightful quail by hearing its ringing, *bob-white*, between caves or, better still, by startling a covey into flying across the road ahead of the car. What a satisfaction it is to know that this bird, whose preservation is important not only to the sportsman and the farmer but to all those who are stirred by its cheery voice, has so far been respected by the boy with the gun that it still remains to enrich the Mammoth Cave country. Its call was often heard by Giovannoli all through July, and it was occasionally seen in July and August.

An illustration of its value to the farmer has been given by Edwin L. Moseley in the Wilson Bulletin. In Ohio "for more than half a century," he tells us, "the Colorado potato beetle had been a very serious pest wherever potatoes were raised," but after a ten-year closed season on bob-white, potatoes were raised successfully on many farms without spraying. One year a farmer raised about fifty bob-whites on his place and for two years had no trouble with insects on potatoes or cabbages. But then a number of the birds were killed and frightened away by hunters and the following summer "the potato beetles were back in numbers." As a result, this intelligent farmer "is again raising bob-whites and protecting them from hunters." Besides helping to protect the potato crop, the bob-white destroys many insects that injure the corn and espe-

cially the tobacco crops, among them cutworms, spined tobacco bugs, tobacco flea beetles, chinch bugs, corn-seed beetles, and the southern corn-root worms.

From Biological Survey.

Fig. 24.—Bob-white.

Unfortunately, the Kentucky 1933 open season — from November 15 to January 1 — does not seem planned to help the farmer.

In Washington, which is a bird sanctuary, every covey of grail is mapped and in severe winter weather fed by the Audubon Society.

The home life of the bob-white, as Edward H. Forbush well says, "has much of human interest." That he is not only a good husband but father has been well illustrated by a family watched by Walter M. Rosen. The mother bird was found carefully brooding twelve white eggs of a late nest on September 6, but on September 15, as Rosen approached carefully he was shocked to find "a mass of brown feathers" in front of the nest. The poor mother had been killed during the night and nothing remained but her feathers. The eggs, however, had been spared and Rosen found, greatly to his satisfaction, that "Old Bobbie" the father, was now brooding the eggs. As he says in concluding—"our old faithful friend Bobbie had now undertaken the job of raising a family, which sometimes is the lot of a lone widower."

EASTERN TURKEY: *Meleagris gallopavo silvestris* Vieillot [310a.]

The date when native wild turkeys were last seen in the Mammoth Cave region was variously given us. "Lennie Daw-

sey," ferryman of the Mammoth Cave ferry across Green River, told Mr. Bailey that none had been seen in twenty years; Dick Navel, of Cave City, an old inhabitant of the region, said the last were seen not more than fifteen years before; and the keeper of Colossal Cavern said the last he knew of were seen there five years before, in 1924.

As many were reported in the state in 1921 and 1922, and as there is now no open season on wild turkeys, it is to be hoped that they may hold their own until public sentiment develops for their protection.

An encouraging sign was noted by the Lexington *Leader* under date of January 11, 1922, three men being reported arrested in McCreary County "for killing wild turkeys in violation of the game laws." In the *Bulletin* of the Kentucky Fish and Game Commission for October, 1932, the success of wild turkeys liberated at Mammoth Cave was reported from Mr. Charlet, the hotel manager. Three broods of five, twelve, and eighteen that he knew of were on the south side of Green River, while some of the old birds that he was unable to check, ranged on the north side of the river. Many more turkeys should be liberated in suitable places and carefully guarded. The state cannot afford to lose its proud record of the possession of this king of American game birds.

KILLDEER: *Oxyechus vociferus vociferus* (Linnaeus) [273.]

Common along the streams of Kentucky, the killdeer finds suitable feeding grounds about the ponds in the immediate vicinity of the caves, and at one of these above the main entrance to Mammoth Cave, all those seen by Giovannoli were found, principally in August.

The killdeer may well be one of our best-known and favorite birds. Ranging over North and South America, and wintering in the east from Indiana and New Jersey, it may be met with over much of the country at all seasons. The familiar *kill-dee, kill-dee,* endeared by long association, is often heard while passing wayside lakes or ponds in an automobile, and sometimes where water is scarce the familiar double-collared figure with the pale reddish brown rump may even be flushed from scant puddles in the roadway.

If you are fortunate enough to meet with one in the nest-

ing season on a mud flat, in a cornfield, or potato patch, it may treat you to an enlightening exhibition of color markings and their uses in conjunction with directive and protective actions. By instinctively waving its flags before you, it leads you on till at a safe distance, when quickly furling them it leaves you to hunt in bewilderment for its vanished form.

An unusual nesting site, the roof of a grand stand in a fair ground, has been recorded by Gayle B. Pickwell in the Auk.

When surprised with a young family, the terrified appealing cries of the devoted parents and their frantic efforts to decoy one away from their young at whatever cost to themselves entrench them in one's affections.

Good photographs, published in Bird-Lore, have been taken of brooding killdeer and their young by Hiett and Flickinger by use of the automobile, dummy camera, or blind, and by tethering the young in focus.

From Biological Survey. L. A. Fuertes.

Fig. 25.—Killdeer.

Fortunately there is no open season on killdeer or on any of the interesting group of shore birds.

AMERICAN WOODCOCK: *Philohela minor* (Gmelin) [228.]

The woodcock is a migrant in the state, with a few summer records. One was flushed several times on July 22 by Giovannoli at a pond near Mammoth Cave.

Well known to hunters throughout the land, the woodcock with its long bill, plump round body, and warm wood colors should be still better known to all true nature lovers. Its unusual habits offer rare pleasure to the looker-on and its remarkable adaptations in form and color to its unique methods of making a living excite the admiration of all those inter-

ested in the beneficent working out of nature's laws. A group of holes or "borings" in soft earth that look as if made with the point of an umbrella make you exclaim—"a woodcock has been here!" For by probing deep for earthworms with its remarkably adapted long sensitive bill to locate them and the flexible tip to extract them, this singular bird supplies itself with food, under favorable conditions consuming, we are told, as much as half a pound of earthworms in a day. Flat feet with long, widely spread toes serve well in the favorite haunts of this "recluse of the boggy thickets," as Bent denominates it. A big eye set high above its ear gives it a wide field of vision—apparently enabling it to look both ahead and behind—while the large size of the eye, as Glover M. Allen in "Birds and Their Attributes" explains, is probably "an adaptation for dusk- or night-feeding." In the daytime, when on discovery it squats motionless among the leaves and twigs, its cinnamon color and mottlings of brown and black produce what Abbott Thayer calls a disguising ground pattern, blending into the surrounding vegetation and shadows.

From Biological Survey. L. A. Fuertes.

Fig. 26.—Woodcock.

Another adaptation in color and pattern is shown in the white tips marking the underside of the tail feathers. A brooding bird, assumed to be the mother, as is told in Bird-Lore, was flushed from her nest by Robert C. Murphy. The bird, as he describes it, "standing with tail toward us would raise and spread it so as to show to full advantage the double row of glistening white spots. . . .next, flashing this striking banner slowly, she would move off among the trees in the manner of a strutting turkey cock, stopping when we refused to follow, and then tripping ahead for a few steps,

all the while bleating softly. The effect was astonishing. . . for the spotted fan of the tail had become a most conspicuous and arresting mark."

This remarkable display is also used in courtship. A cock that Edward A. Preble once caught sight of was "an almost grotesque figure as he strutted with elevated and wide-spread tail and drooping wings." The best known courtship exhibition, however, is what Bent calls the "spectacular evening song-flight." The time to watch for it is "during the laying and incubation period"—December and January in the Gulf States, April in Massachusetts. The performance, which usually begins soon after sunset on moonlight nights, is sometimes continued all night. It is given from the nearest open space to the nest, where the cock entertains his mate "with his thrilling performance." He mounts into the air on a long plane that to one observer suggests a rising aeroplane, his rapid wing-strokes and vibrant whistling notes carrying out the airship suggestions. After rising spirally to a height of two or three hundred feet, as William Brewster describes it in his Maine notes, the woodcock will "descend earthwards by a series of zigzag swoops made with arrow-like speed, and accompanied by successive outbursts of ecstatic, liquid, gushing song." Interesting diagrams of the flight song have been published by Loring W. Turrell in the Wilson Bulletin.

Watching the flight song of the woodcock is one of the rare experiences of the bird lover, but more intimate pleasure may be had by the patient bird photographer. Some pictures published by Tappan Gregory in Bird-Lore, were so cautiously made that at the last the brooding bird allowed him to stroke it on the nest.

It has been reported that in cold or wet weather both birds sit on the nest. When the young have hatched and are in apparent danger they are sometimes carried off by the parent between its thighs and even in its feet. One old bird was flushed by A. W. Shorger, as related in the Auk, at a distance of a few feet, and "clasped between the toes was a young bird about one and one-half inches long."

Altogether the woodcock is one of our most notable birds. But, sadly enough, its numbers have become alarmingly depleted. In general this is due to increase in population, drainage of its feeding and nesting places, spring burning of woodlands destroying its eggs, and severe storms during its early spring migration; but especially is this due to market hunting, more effective firearms, and improved methods of transportation. Market hunting is now outlawed, spring and summer shooting is stopped, and the open seasons limited to late fall. Nevertheless, as Funkhouser states, "the woodcock is still being rapidly exterminated by hunters." In Kentucky it is sadly in need of protection, but most unfortunately, still suffers from a month's open season.

As Preble urges in Nature Magazine, throughout its range the utmost safeguards should be placed around the woodcock—one of the most remarkable of all our American birds—"that a tragedy like that of the passenger pigeon may be averted."

EASTERN SOLITARY SANDPIPER: *Tringa solitaria solitaria* Wilson [256.]

At Bowling Green, on its fall migration, Dr. Wilson has found the quiet solitary sandpiper from July 28 to October 11. At Mammoth Cave, Giovannoli saw one several times during the latter half of July and shot it on August 26, for positive identification.

As Alexander Wetmore states in the Migration of Birds, "However we may attempt to explain the phenomenon, the facts remain that many birds of this group [shore-birds] start south very early, so that by the middle of July in the northern United States migration is well under way in a number of species. . . Passage southward in many individuals is rapid." In 1912, in Porto Rico, the solitary arrived on July 29, and in 1920, in southern South America, it reached Rio Paraguay, on August 23. But not until the middle of November had arrivals from the north ceased and birds of this group settled on their winter resting grounds.

The retiring solitary is a frequenter of fresh-water ponds, and especially of woodland pools, and has the peculiar habit of nesting in the deserted nests of tree-building birds, such as robins, kingbirds, bronzed grackles, and cedar waxwings.

As the teetering spotted sandpiper is also a common migrant in Kentucky, and Gordon Wilson has found it a rare summer resident, it is important to distinguish between the two birds. In the summer adults, while the darker solitary is somewhat larger than the spotted, the main differences observable at a distance lie in the large white spots on the underparts of the spotted, which in the solitary are plain white, with only fine streaking on the neckband; also in the blackish wings of the solitary, with black and white barred axillars shown in the raised wing; and in the spotted, the diagnostic broad white bar, *shown in all plumages*, on the spread wing. In the hand, the black markings on the back of the spotted are seen to be replaced by flecks of white in the solitary. In winter plumage, however, both adults and young spotted sandpipers are unspotted below, the sides of the neck and chest being suffused with drab; but then the markings of wings and tail are diagnostic.

EASTERN MOURNING DOVE: *Zenaidura macroura carolinensis* (Linnaeus) [316.]

The length of the present Kentucky open season on mourning doves—from September 1 to December 15—makes it important that no thoughtless shooting be done in the closed season. Apparently the law is respected in the Mammoth Cave region as doves were abundant there "in the woods and fields" in summer, although wary and seldom seen after two weeks of the open season. On July 22, Giovannoli scared a dove from her nest "with at least one egg in it." He frequently noticed them in the gravelled roads apparently picking up grinding stones for their gizzards.

As it has been explained their swift flight, which helps them escape from hawks, their adaptability to different

environments, and their long nesting season with presumably three broods a year, may compensate for their low order of intelligence, their clutch of only two eggs and their frail nests often destroyed by heavy storms.

Many interesting suggestions for observation of these familiar birds have been offered by Frank E. Gander; and more still by Mrs. Margaret M. Nice, who has published a careful elaborate study of their nesting habits in the Auk.

Both the male and the female, Gander states, "engage

From Biological Survey.

Fig. 27.—Mourning Dove.

in the search for the nesting site, but the final choice rests with the female." In building, Mrs. Nice finds that the male "gathers the materials and carries them to his mate who arranges them." With more industry than intelligence he carries only "one piece at a time, and if he happens to drop it he does not stop but continues his journey to the tree and then starts out over again." As Mrs. Nice infers, "this laborious practice of a straw at a time is probably one reason why doves' nests are such poor affairs." A large number of these fragile nests placed on horizontal branches come to grief, but those supported in crotches are almost twice as successful. When the nest is well under way, Gander notes, if the female leaves her work, the male follows the curious practice that pigeon breeders call "driving," following her about and pecking at her until she returns to her duties!

Sometimes the birds build on top of the nests of other birds and, by two records, even of squirrels. Their habit of using the nests of other birds, Mrs. Nice found, "occasionally results in doves incubating eggs of other species." So the low order of intelligence shown in carrying only one straw at a time also leads toward the degeneration of nesting habits shown in the cowbird. Both parents incubate and brood, the male during the day, the female "during the night, early morning, and late afternoon. . . both parents regurgitate 'pigeon-milk' for the young."

Two striking differences between mourning doves and most perching birds, Mrs. Nice finds, are the constant brooding of the young until they leave the nest and "the lack of any sanitary care of the nest." Degeneration of habit was also shown in the doves watched by Mrs. Nice in the broken-wing ruse when the birds are frightened from the nest and wish to lead the intruder away. "At least thirty per cent never exhibited the broken wing ruse; a few showed it throughout the nesting cycle, but most exhibited it only when the young were half or nearly grown." The form of the ruse, a "pretense of injury," has also degenerated. Although, if much distressed, a dove will throw itself on the ground "near the intruder and

flutter about as if seriously injured," more often one flies off for "perhaps ten to thirty yards, flutters a little on the ground, stops and waves its wings, then walks along waving its wings, making little flights into the air and then again walking along flapping its wings," in this way demonstrating to human intelligence its uninjured condition. But the question is, how fine are the distinctions made in the matter of ruse by the dog or other follower, with only animal intelligence.

An interesting account of the mourning dove in the south in the early days is given by Pearson in his Educational Audubon Leaflet (No. 2).

PASSENGER PIGEON: *Ectopistes migratorius* (Linnaeus) [315.]

The last of the known passenger pigeons, whose hordes once darkened the sky, died in captivity in 1914, so closing the most remarkable history of any American bird.

Descriptions of its former roosts in Kentucky described by Audubon, Wilson, and others are cited by Funkhouser, and although no definite localities have been given for the Mammoth Cave region, roosts were so near that the pigeons must have crossed back and forth over the country.

A general account of the bird is given in an Educational Leaflet of the Audubon Society, by Forbush, who calls it undoubtedly one of the greatest zoological wonders of the world and formerly the most abundant gregarious bird known in any land, ranging over the greater part of North America in innumerable hosts.

YELLOW-BILLED CUCKOO: *Coccyzus americanus americanus* (Linnaeus) [387.]

As is usually the case where it lives, the yellow-billed cuckoo or rain crow was seen occasionally but heard frequently by Giovannoli during July and August at Mammoth Cave, one being noted on July 12 near Horse Cave. Twenty years before—June 29-July 5, 1909—two were seen there by Arthur H. Howell.

Living largely on hairy caterpillars, though also eating the southern tobacco worm, this long brown bird, too large

for safety in the open, flies swiftly and silently from green cover to green cover, perhaps from a roadside tangle hung with tents of the tent caterpillar to an orchard where its good offices are sorely needed. It disappears among the leaves so quickly that one is fortunate to catch sight of the big white thumb marks on its tail and the reddish brown on its wings that distinguish it from the less strongly marked black-billed cuckoo, which migrates through the general region.

From Biological Survey.

Fig. 28.—Yellow-billed Cuckoo.

The calls of the yellow-billed, which along the countryside are supposed to foretell rain, are well described in Eaton's Birds of New York "as a series of loud and explosive gutterals resembling the syllables *kuk-kuk, kuk-kuk,* repeated many times and ending with the syllables *kyow, kyow,* repeated from two to six times. Occasionally it utters a low, somewhat liquid *coo, coo, coo, coo.*"

The peculiar quality of the loud cries, which may be nearer or farther away than you imagine, adds to the teasing mystery of this elusive bird whose notes the poets have celebrated.

See Pearson, T. G., Educational Leaflet 15, Nat. Assoc. Audubon Soc.

EASTERN SCREECH OWL: *Otus asio naevius* (Gmelin) [373m.]

Birds that fly in the light of day may be thought of hopefully by the veriest layman, for by walking abroad with eyes and ears alert that may be met with, and their pleasant acquaintance made; but those that fly by night, whose voices are heard only from the darkness, may well seem beyond one's ken, birds of mystery whose acquaintance can only be made by the patient explorer of hidden places in the untrodden

depths of the forest. And yet these creatures of mystery are among the most interesting of all our birds.

Fortunately for the casual observer there are some exceptions, some of the family whose strange ways may be watched outside the forest primeval. The delightful little screech owl is one of these. Attracted perhaps by the abundant supply of English sparrows—for its food depends on what is most easily secured—it has even been found inside the cities of New York, Boston, and Washington. In favored country places it will sometimes accept the proffer of a nest box, and old orchards whose neglected trees offer inviting hollows are among its favorite nesting sites.

From Biological Survey.

Fig. 29.—Screech Owl.

A pair watched carefully by the bird artist, George Miksch Sutton, nested in an apple tree near his house and gave him many interesting experiences. When the little ones were "old enough to clamber about their nesting chamber and to stick their comical heads out," he tells us, "they sometimes squealed for food, but the parents never began feeding before twilight." When watched one evening for three-quarters of an hour, one of the old ones—apparently the mother—spent her time catching the big June bugs that were flying about an elm tree. Some of these she evidently snatched from the twigs or leaves with her feet; others she caught in mid-air with her beak. . . . She caught about two insects a minute, returning promptly to feed the noisy young." The other parent did not come to the nest and, the artist inferred, was away hunting for larger quarry, very likely field mice, of which it takes a large toll. As Preble states the case, the screech owl "is one of the night watchmen that guard our property."

When surprised away from the nest, the small owl, well

taught by Mother Nature, assumes remarkable protective attitudes, as Louis Agassiz Fuertes has shown us, drawing itself up until it looks comically like the bark of the tree that is its background.

These droll little screech owls, known as the commonest owls in Kentucky, have been reported from Cave City and Green River, and we were greatly pleased to hear the quavering voice of one in the heavily timbered bottom land near the Mammoth Cave ferry.

But this quavering call of the small owl, known in Louisiana as the "shivering owl," like the cries of other mysterious unseen birds of darkness listened to by the superstitious of whatever color or clime, has supplied rich material for folk lore. Belief in their terrifying prophesy of death or disaster has suggested many protections, one of the commonest perhaps being to reach from your bed and turn your left shoe upside down!

Just why the tremulous cry of this little owl should seem to have a melancholy or threatening ring it is hard to imagine for, as Elon H. Eaton analyzes the cry, "it is as much the expression of a healthy, happy, vigorous and sociable personality as the chickadee's cheery note" and most of the small owl's nights are spent in the prosaic pursuit of insects and mice to satisfy the hunger of itself or its young.

The "screech" for which it is named, Preble has heard many times, "usually in the stillness that comes after midnight," and on a few occasions it has been "actually startling." Using as text this seldom described screech, he urges that the "earnest student keen of hearing and apt at describing what he hears," makes a study of the notes of our owls, none of which he believes "is more versatile than our little tufted friend."

See Dutcher, William, Educational Leaflet 11, Nat. Assoc. Audubon Soc.

GREAT HORNED OWL: *Bubo virginianus virginianus* (Gmelin)
[375.]

A great horned owl in a large out-door cage kept conveniently near the kitchen of the Mammoth Cave Hotel

testified to the presence of the big bird in the immediate neighborhood. Another was brought in during the summer and Giovannoli was told that they are easy to catch with a chicken as bait.

That this large bird, of great potential usefulness to man in its destruction of injurious rodents, will not refuse chicken left in its path is indubitably true. But as it feeds mostly at night, if poultry is properly housed its efficient help may still be taken advantage of by the farmer in his unending struggle to keep down the small injurious mammals.

From Handbook of Birds of Western United States.

Fig. 30.—Great Horned Owl (Pallid).

As with other owls, the hawks, and many other birds that swallow their prey whole, all the indigestible parts—bones, fur, and feathers—are regurgitated, thrown out in the form of smooth-coated pellets with the dangerously hard, scratchy parts inside; and in the case of the owls these often supply a goodly list of the small mammals of their region.

Two detailed studies of the nests and young of the great horned owl have been published by Miss B. P. Reed and Leon L. Gardner in the Auk, in which many interesting facts are recorded. In the young studied by Miss Reed the hearing was so acute that the slightest sound could be heard and located, and their eyesight was so keen that even in broad daylight one watched the flight of a robin three hundred feet away and the movements of a dog a block away. When their pupils were much dilated—as from anger—the irises took on a reddish tinge. The behavior of the young owls led Miss Reed to believe that "some individuals could easily be tamed, as three of

hers showed gentle dispositions that could easily be cultivated."

Besides the familiar *who-hoo-hoo-hoo-hoo* of the great horned, there is sometimes heard "a terrifying shriek," as Preble describes it. But, he adds, "Those who find inspiration in the sounds of nature will find it easy to forgive this fierce bird his occasional meal of grouse or barnyard fowl in return for the opportunity to hear his deep mysterious hooting in the lonely glen, or see him take his watchful perch on some favorite lookout tree in the gathering dusk."

EASTERN WHIPPOORWILL: *Antrostomus vociferus vociferus* (Wilson) [417.]

The well-known call of the whippoorwill, which was heard in April by Mr. Bailey near the cave, can be heard, Giovannoli says, "any night all summer if one is near the woods." Two birds were calling at once on July 13. When the call is close to the house, some find it hard to sleep, but when at a little distance in the stillness of twilight or when the full moon lends glamor to all below, the "wandering voice" with its soft rich notes is full of poetic suggestion. Heard near by, the *whip-poor-will* is oddly preceded by a *chuck* and the rapid calls are given with force and emphasis.

In the mating season, Forbush has observed, "the Whippoorwill often continues to enunciate this cry until it would seem that he must drop from exhaustion, turning about occasionally or moving to another perch and sending forth his call to a different point of the compass." Six hundred and sixty-four times, C. W. Townsend has heard the *whip-poor-will* repeated without a break and after a few seconds the bird began again. A still more remarkable count was heard by John Burroughs, one thousand and eighty-eight, "with only a rarely perceptible pause here and there." But ordinarily, Forbush found, "one hundred consecutive calls is a large number." The song is given most continuously, at Plymouth, Massachusetts, Frank S. Hersey notes, from dusk until about half past nine, and from two o'clock until dawn.

An interesting nocturnal migration wave reached Ply-

mouth on May 5, 1901. On the evening of May 4 the first bird of the season was heard singing. At two o'clock the following morning, Hersey recounts in the 1923 Auk, "I was awakened by birds singing loudly everywhere. I dressed and went out and for more than an hour the chorus continued. There were numbers of birds about the house, on the doorstep and ridgepole, others singing in the road or from the stone walls along the roadside, while others still could be heard in the pastures—often eight or ten were singing at the same instant. I walked down the road for half a mile and the birds seemed equally abundant on neighbor's farms."

From Biological Survey. L. A. Fuertes.

Fig. 31.—Nighthawk, top and in air; Whippoorwill, middle; Chuck-will's-widow, bottom.

Migrating, singing, and also feeding have to be done at night to leave the daylight hours free for rest. Night-flying moths, including some of the worst pests of the forests, make up a large part of its food, for it is one of the force of night-flying birds that help hold in check the nocturnal enemies of man. It is well called "an animated insect trap," its bristling bill opening from ear to ear to take in big moths that the smaller diurnal birds leave behind. It does not limit itself to the capture of large insects, however, as Forbush learned when sleeping in the woods with only a head net to protect him from mosquitoes, for before daylight the whippoorwill would come and flutter softly about his net until it had caught all the mosquitoes.

When hunting, the whippoorwills like an open space and often alight on the roads at night, whereupon the puzzled

automobilist sees large red eyes glowing before his headlights.

A close relative of the whippoorwill, the chuck-will's-widow, figured at the bottom of the Fuertes drawing, Wilson found a fairly common summer resident at Bowling Green, and it should be watched for in the cave region. It is larger than the whippoorwill, with rictal bristles having lateral filaments, and its bill has such an enormous gape that it has been known to swallow hummingbirds and sparrows. Its notes which are similar to those of the whippoorwill, Dr. Chapman says "are louder, less rapidly uttered, and each call has an additional syllable."

EASTERN NIGHTHAWK: *Chordeiles minor minor* (Forster)
[420.]

Nighthawks, with the white wing band, were heard and seen about Mammoth Cave in small numbers, Giovannoli reports, "during most of the summer and in larger numbers during late August, the increase being no more than what might be expected from local breeding." A few were seen by us on September 15 in the sky over Cave City, and on September 17 a small flock was seen passing, moving so rapidly, weaving about over the houses and up against the clouds that it was hard to count them. Swift and strong-winged, so well able to escape their enemies that they migrate in broad daylight, they were passing south, though feeding as they went on flying insects, as do the long-winged swallows and swifts.

More than six hundred species of insects have been found in nighthawk stomachs—about a quarter of them winged ants—and some very destructive, as cotton boll weevils and others injurious to tobacco and corn. One stomach contained five hundred mosquitoes.

In the sky the white wing band of the nighthawk holds the eye and names the bird, but in the hand both whippoorwill and nighthawk resemble their woods background. "How can you tell them apart?" the puzzled layman demands, looking at their big mouths and woods colors. Flushed in the daytime, the nighthawk darts up with white

wing bands outspread but on realighting closes its wings and instantly disappears. In other words, it is protectively colored when at rest, but has white directive wing marks that enable the flocks to keep together when on the wing.

The notes of the two birds belong to different classes. Those of the whippoorwill Aretas A. Saunders puts in the class of a real night song. Those of the nighthawk, on the other hand, are two, a single call note—*peent*—given as the bird flies around overhead, and a loud booming sound made in headlong plunges by the rush of air through the wing feathers, appropriately classed by Dr. Townsend (1920, p. 391) as instrumental music. As this unique music is produced in courtship display, the Doctor calls it also a form of the dance exhibited by various birds.

The *peent* and the boom are both often heard in cities, as flat gravelled roofs afford good nesting sites—nesting sites by courtesy, as the nighthawk generally lays her eggs on bare ground or a flat rock. One surprising nesting site was discovered by V. Max Kemery, as told in Bird-Lore, between the rails of a railroad track over which cars passed nearly every day. When the eager photographer put his hand down close to the mother bird brooding her eggs, he tells us, "she attempted to chase me away by spreading her wings and tail and making a hissing noise but never trying to strike me with beak or wings."

See Beal, F. E. L., Educational Leaflet 1, Nat. Assoc. Audubon Soc.

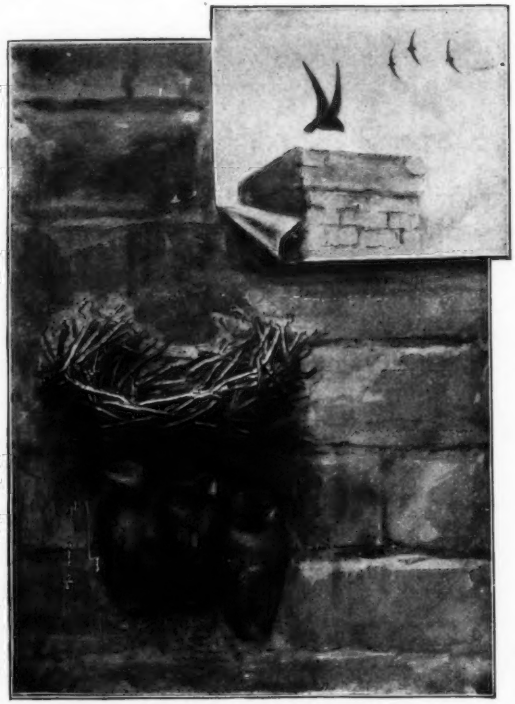
CHIMNEY SWIFT: *Chaetura pelagica* (Linnaeus) [423.]

The chimneys of the Mammoth Cave region are too few to attract many chimney swifts, abundant at Bowling Green, but a few were seen by us late in April, individuals or pairs by Giovannoli in July and August, and large numbers of migrants by us in September.

We found one of their humble nesting places across the old fields from Onyx Cave, at the end of an overgrown road, in an old log cabin with outside chimneys and a patch of tobacco. The woman, rather bored by my eager question, indifferently acknowledged that the swifts had nested there during the summer, but she hadn't noticed anything lately.

Below the cabin, in a field of cornshocks towered over by a great chestnut tree, killed by girdling to make room for more corn, late in the afternoon three swifts—presumably separated from their migrating comrades (it being the twenty-second of September)—came flying in to the dead top and as if hunting for an emergency night's roost flew persistently around and around it and the holes in its dead branches. At last, apparently finding nothing to their liking, they disappeared as they had come, through the sky.

A few swifts had been seen the week previous at Cave City and we were told that in years past there had been a roost in the chimneys of Maplehurst on the Dixie Highway.



From Handbook of Birds of the Western United States. E. T. Seton.

Fig. 32.—Chimney Swift.

On September 26 a number were seen flying around over the town, and on September 27 some were heard chattering during the day. Late that afternoon, at 4:40, after a rain, they were flying high in the sky, their small black forms spectacularly crossing in front of the arch of a vivid double rainbow. Later—about six o'clock—a number were seen going to roost in the large chimney of the town school building, and the next morning, at breakfast time, a few were seen about the school.

Two days later, September 29, when we started out at roosting time, heavy storm clouds were gathering, but instead of hurrying down the school chimney for shelter from the threatened storm, the swifts were flying about high in the sky feeding unperturbed and when—still more to my surprise—the blackest clouds, with almost funnel-form menace moved off toward the south, they were left to go on quietly with their evening meal. Have these areonauts a peculiarly developed sense of prognostication? Living among the clouds they might well know better than we of-the-earth what to expect in the sky.

After a time, as more and more birds gathered in from the outlying country, those that were feeding joined the newcomers and they began to mill. When all were gathered there were only about five hundred and the close mass movement one often sees with roosts of several thousands was not possible. It was more a movement of separate individuals suggesting at times a black milky way. In a wide irregular circle, around and around they went above the large building, where one big chimney and two small ones offered shelter. Once and again the black circle would bulge, swerving out to the south—was it possible that my crossing to the tennis court below for a better view had been noted above? In any case, drawn by the magnet of the big chimney—the small ones were ignored—back would come the black line and the circling continue as before.

Not long after a few individuals thought they wanted to go to roost. But, though raising their wings straight above their backs for the drop, most of them before reaching the chimney would change their minds and start off again with the milling crowd. Some, however, would actually drop down inside and then fly out again. The milling was prolonged till I wondered at its cause. Is it a social or flock instinct that

makes them wait till all are there? And if so, how can they tell when all have come? Their actions suggested children reluctant to "go to bed by day." And, indeed, why should they plunge down the black chimney mouth when they might be flying about in the free open air? Chattering like a great band of happy children held by the delights of the game, they coursed on around and around. As I watched, their black, insect-like forms were projected against buffy tinted clouds lighting up the gray sky. Above them a bright salmon sky window with gilded casement suggested a fit lookout from which a joyous spirited Audubon might enjoy their play.

But it would soon be dark—they must get settled for the night. In milling, as they came over the chimney they began to drop down, a few at a time. There was no sudden general drop as in roosts of thousands, but when the descent had fairly begun it kept up until all in sight had disappeared. Then, as if the arrival of the clan had really been waited for, a single belated individual came hurrying across the sky and dropped in. Apparently that was the end of the chapter—at exactly six o'clock—none too soon as the overcast sky made darkness come early.

The loud chattering that had accompanied the milling stopped when the birds dropped below, probably because the sound could not reach me from inside the chimney. For even five hundred to get comfortably hung up on the narrow black walls might involve some discussion. Apparently there is a conventional form to follow. The first to enter a chimney, Forbush has explained, "arrange themselves in a row near the top and the later entrants perch in tiers below." But in a chimney climbed by Thomas E. Musselman when engaged in banding swifts, after a severe snowstorm when the usual forms may have been disregarded in the stress of the moment, he found probably three hundred clinging to the sides of the brick wall four feet down and in a solid mass, three birds deep on all four walls.

The swifts not only sleep, but nest in chimneys and in wells, cisterns, buildings, or hollow trees, and they also roost in caves. The great roosts that we enjoy in the fall are made up of birds on their way to their winter quarters, presumably in the tropical forests of northern South America. As Dr.

Wetmore in Migrations of Birds says, "for six months of each year [the swift] frequents settlements in the north, where it nests and roosts in chimneys, or casually, in barns and outbuildings, while during the winter season [there being few chimneys in the Tropics] it must revert to the ancient custom of its race, truly a curious mixture of habit."

See Pearson, T. G., Educational Leaflet 49, Nat. Assoc. Audubon Soc.

RUBY-THROATED HUMMINGBIRD: *Archilochus colubris* (Linnaeus) [428.]

From Handbook of Birds of the Western United States. E. T. Seton.

Fig. 33.—Ruby-throated Hummingbird.

Two of the tiny green-backed, ruby-throated hummingbirds, the male of which flashes a jewel as he flies, were seen by me about the scarlet catchfly near the caves, presumably on their first arrival from the south. The date—April 22—is the earliest quoted for Kentucky by Funkhouser. On May 1, 1920, at Bowling Green, Wilson reports seeing what may have been a newly arrived flock gathered at a fragrant red-flowered buckeye, twenty or more of the birds being in sight all the time while others were perched in the tree. If migrants, their arrival was well timed, but as Dr. Wetmore has pointed out, in their range hummingbirds appear and disappear with the flowering of certain vines, trees, or plants. Some of our western ones follow up and down mountain sides with the blooming of the flowers. How much territory they cover on their survey for food it would be interesting to know, and still more so to know, what the bird banders may some day be able to tell us, how far south individuals that nest in Canada go to spend the winter and how far north those that winter in Panama go to build their nests.

The wing power that enables these tiny "insect-like creatures," as Bradford Torrey calls them, to make long migrations is certainly to be marvelled at, but a glance at the large flying muscles attached to their breast bone offers an explanation of their possibilities. When they dart past you, how fast are they going? On a two hundred yard dash recently recorded by the speedometer of Samuel P. Hayes, Jr., in his accompanying automobile, one actually flew at the rate of forty-five miles an hour.

When you see one darting by or standing in air probing a flower tube with wings whirring so rapidly that they are a mere blur, you feel with Bradford Torrey—"Verily, a marvelous spirit and energy may be contained within a few ounces of flesh! . . . How slow, overgrown, and clumsy human beings must look in his eyes!"

At Mammoth Cave in summer Giovannoli saw the hummingbirds "about wild flowers in the woods and cultivated flowers near houses." How late do they stay? On September 15 I saw an adult male at Cave City and on September 18, a female or immature at Mammoth Cave, where on September 28 I saw one flashing about the cosmos at the hotel. Although as the flowers go out of bloom with the fall frosts there is nothing to detain them longer, some individuals have lost their lives by waiting too long before starting on their southward journey.

The dainty flower birds, attracted by the bright colors of the blossoms, probe them for nectar and tiny insects, flying on in their unconscious work of pollination carrying pollen from one flower to another. A fairly horizontal flower tube seems the easiest to probe, and one brilliant orange flower—with as yet no common name but known to the botanists as *Macranthera lecontei*—found on the gulf plain from Georgia to Mississippi, has developed a most remarkable adaptation to serve this need. By means of a spring-like bracket in the stem, its erect candle-like tube actually bends down under the weight of the hummingbird to a horizontal position. This Andrew L. Pickens has figured in the Auk and considers the most delicate adjustment shown by any flower in the United States that caters to the ruby-throat.

So eager are the hummers for the nectar they find in flower

tubes that, as Miss Margaret L. Bodine has recorded on several occasions, they may be attracted to even a small porch by tubular bottles containing sugared water. At first the bottles should be hidden in some bright-colored material, but when once they are known to hold syrup, no disguise is necessary and the birds even light on friendly fingers and allow themselves to be carried about, as is shown in Miss Bodine's photographs and moving pictures.

A droll example of the hummingbird habit of investigating all bright-colored objects was witnessed by Miss Bodine on her porch. A young hummer, evidently mistaking a brilliant raspberry-colored male purple finch with the sun on him for a sweet flower, darted at him giving him repeated jabs. "The finch, appearing much bored, moved from spot to spot and finally flew away."

EASTERN BELTED KINGFISHER: *Megaceryle alcyon alcyon* (Linnaeus) [390.]

The rivers and ponds of Kentucky attract the belted kingfishers in summer and a few are said to remain in Fulton County through the winter. Late in September, on a trip

From Handbook of Western Birds.

Fig. 34.—Kingfisher.

down Green River to Bat Cave, about four miles below Mammoth Cave ferry, Mr. Bailey saw several, one by one, or possibly only the same one flying along, the motor boat scaring him up and making him fly, rattling as he went.

One who has heard his loud startling rattle or has seen his pale blue form passing swiftly over a stream will always

think of him as a notable bird. Sometimes he is caught sight of hovering in air with body slanted sharply down as he inspects the water below. At other times he may be seen flying to a dead branch on the shore, as he alights rattling, raising his big crested head and tipping up his short tail with comical cocky effect, after which he stands with big bill ready for minnows or any other small fry that chance to swim by below. Suddenly, down he plunges, sometimes going entirely out of sight under the water, then flying back to his perch, where he shakes himself dry and proceeds to swallow his catch, head first.

In the spring, after his arrival from the south, the solitary fisherman finds a double-belted mate and together they go to nest making. A perpendicular bank is commonly chosen for the excavation of the horizontal burrow, which extends from four to eight feet and ends in a nest chamber eight to ten inches in diameter. The male apparently does the major part of the excavating as his bill, Forbush found "is usually more scarred by contact with stones and gravel than that of his mate." Although this bill is used as a pick-axe, the specialized tiny feet, with toes grown together, are used as shovels to throw out the earth excavated.

When the mother kingfisher has commenced to incubate the eggs, Eaton assures us, "she will usually defend them against all intruders, as many a small boy who has tried to unearth her treasures can testify from the wounds which her dagger-like bill has inflicted."

Although the location of the kingfisher's cave nest does not lend itself to pictures by ordinary photographers, interesting photographs of the young in various stages of development have been taken by Francis H. Herrick, and many enlightening notes obtained that appear in his delightful book, "The Home Life of Wild Birds."

Other photographs taken from a blind by William H. Gratwick, Jr., published in Bird-Lore, show the mother bringing food to the nest. The pair that he watched from a blind, he says "had as perfectly distinct personalities as two people," the mother being "a person of common sense and hard

work, with the wonderful domestic virtue of getting things done efficiently and thoroughly so different from her husband, a nervous, high-strung individual." This individual difference in birds of a pair often adds to the charm of nest studies.

See Dutcher, William, Educational Leaflet 19, Nat. Assoc. Audubon Soc.

NORTHERN FLICKER: *Colaptes auratus luteus* Bangs [412a.]

Kentucky and the Mammoth Cave region are fortunate in having a large representation of the family of woodpeckers, most of whom by hard labor in drilling for woodborers and persistent hunting for injurious insects have earned the goodly name, conservators of the forest. Their remarkable adaptations to their work in chisel-like bills, barbed, extensile tongues, and clinging feet are equalled by that of the structure of the skull, which Glover M. Allen, in Birds and Their Attributes, explains "is large in proportion to the neck and heavy-boned to resist the strain of sharp blows."

From Biological Survey.
Fig. 35.—Flicker.

As the varied and rich forest growth of Kentucky is one of the most attractive features of the state, any help in its preservation should be highly valued and the helpers carefully protected.

The familiar flicker, or golden-winged woodpecker, of the cave region is recognized in flight by its golden wing linings and, whenever the wings are dropped, by the big white patch at the base of the tail. Its brown barred back gives a clue to its habits for it is largely a ground feeder, picking up some tobacco and corn insects and having an

insatiable appetite for ground ants.* In catching them the barbed tongue of other woodpeckers would be of little use, but its own brush-tipped tongue, moistened from its unusually large salivary glands with mucilaginous saliva, serves the purpose admirably. One flicker, W. L. McAtee of the Biological Survey reports, has been known to take more than five thousand ants at a single meal.

One day, when I had been watching a handsome red-headed woodpecker circling gracefully out and back over the pond above the cave entrance, my attention was attracted by a flicker on the embankment of the pond, standing big and high above the trail and hopping along awkwardly on its woodpecker feet, as bad as high heels for walking purposes.

When the flicker is not seen, its presence is made known by its many calls and its drumming, which C. W. Townsend, in the Auk, classes as instrumental music, telling us that he has heard one "interrupt his spring song to drum and later continue with his vocal music."

The loud spring song of the flicker is part of his exuberant and most entertaining courtship perforamnces. In one case, witnessed by Claude W. Leister and his Cornell bird-study class in May, the usual courtship antics were prefaced by unusual aerial evolutions that might have done credit to a hummingbird or a raven. By peculiar bumpy and jerky spirals he climbed to about three hundred and fifty or four hundred feet, when after a short pause, "a reverse of practically the same performance was gone through" and he lit in a cherry tree just above the female whose approval he desired.

At the nest flickers easily lend themselves to photography, as is shown by a family of young photographed by Walter C. O'Kane reaching from the nest for strawberries held enticingly before them.

A delightful true story of a flicker's nest is told by Olive Thorne Miller under the appropriate title of Babes in the Woods.

* Pearson, T. G., Educational Leaflet 5, Nat. Assoc. Audubon Soc.

NORTHERN PILEATED WOODPECKER: *Ceophloeus pileatus abieticola* Bangs [405a.]

From Biological Survey.

Fig. 36.—Pileated Woodpecker.

The northern pileated, or cock-of-the-woods, the largest woodpecker remaining to Kentucky, with black body, red crest, and white wing spots shown as it flies over the tree tops, must be guarded vigilantly to maintain it on the rolls of the state. Following the line of specialization in food habits that Glover M. Allen in "Bird Attributes" has pointed out in the downy and hairy woodpeckers, the larger hairy being more a bird of the forest than the downy, the great pileated is a bird of the large timber. Its "size and increased power," Doctor Allen says, "enable it to cut great holes in the trunks of forest trees in order to reach the tunnels of the big black wood-boring ants which often attack live trees from the root, boring their galleries in the heart-wood far up into the stem."

In hunting for wood-boring ants, Doctor Townsend says, in the Auk, the pileated seems to be able to detect them in the hearts of trees apparently sound, and he quotes Prof. Richard T. Fisher of the Harvard School of Forestry as suggesting that the birds detect borers "by percussion, for a sound tree when struck gives forth a peculiar ringing note, while one whose heart is riddled with borers sounds dull and dead." As the forester distinguishes the sound from the unsound, possibly "the bird with its sensitive beak may also feel the difference as does the expert physician in percussing a chest." As the big slabs torn out of the side of a tree trunk tell that a pileated has been there, so a thumb hole at the bottom of the deep excavation shows where the barbed, horn-tipped bill of the big woodpecker has speared its prey.

A bird of the deep forests, shy and alert for danger,

though its voice may be heard by the fortunate, as it was by Giovannoli and ourselves, in the cave region, tones of sharp alarm follow its recognition of the presence of gun-bearing boy or man, and it quickly falls back to a safer distance. When off guard its notes are delightfully varied in expression. Of three birds that we heard answering each other near Mammoth Cave, one gave a rapid, high and joyous call. Another called *chuck-uck, chuck-uck, chuck-uck, chuck-uck, chuck-uck, chuck-uck,* and on and on as if it would never stop. At a distance the call suggested the flicker's *if-if-if-if-if,* but it was slower and heavier—often like *chuck, chuck, chuck, chuck, chuck.*

As if these notes were not enough to tell its whereabouts to its family, the pileated, like other woodpeckers, signals by hammering on dead or hollow limbs. It is, as F. E. L. Beal has said, "an adept at such telegraphing and its tattoo on a particularly resonant piece of timber can be heard for more than a mile." On the other hand, as we were walking through the woods at Mammoth, Mr. Bailey exclaimed—"Hear that slow heavy pounding on rotten wood? That's a pileated!" And as I listened the muffled quality was so impressive as to be long remembered.

A most interesting account of the haunts and habits of the pileated is to be found in Forbush's Birds of Massachusetts.

In a nest that was watched by Doctor Townsend, as recorded in the Auk, after the female had partly fed the young by regurgitation she "started to enter the hole to clean it and was obliged to push back the young who kept boiling over and out as fast as she pushed them back. Finally, amid a confused turmoil of red cockades and black and white face markings, she managed to push them all back and enter the hole."

The king of all our woodpeckers, the great ivory-billed, which formerly nested in Kentucky, was reported from Henderson by Audubon, and L. O. Pindar thinks it was to be found in Fulton County as late as 1872-1874. It has now been exterminated not only in the state but over the rest of its former range, except, as Funkhouser says, "in the most inaccessible of the southern cypress swamps."

RED-BELLIED WOODPECKER: *Centurus carolinus* (Linnaeus)
[409.]

From Biological Survey.

Fig. 37.—Red-bellied Woodpecker.

One of the greatest pleasures of a visit to the Mammoth Cave region was the presence of the red-bellied woodpecker with its red or gray crown and white barred back. It was even seen, when all was quiet, on the grounds of the hotel as it flew from tree to tree showing white patches on its wings. Once it was seen with something round and white in its bill — perhaps a wood-boring larva — that it was carrying to the woods. A handsome male was discovered on the edge of the woods near the hotel, standing on top of a low stub. As I watched, to my delight he bent his head and the whole top glowed scarlet in the sunlight. Leaning down to preen, his belly feathers parted, revealing a streak of rich red, handsome enough in contrast to the pale reddish wash of the surrounding feathers.

In the woods above the entrance to Mammoth Cave, I was surprised to find three of the red-bellied eating red dogwood berries. To pick them, one that I watched had to twist and cling awkwardly in what looked like most uncomfortable positions.

The varied notes of this woodpecker struck my ear strangely with their odd, raucous quality—suggesting an uncouth, gawky personality. Sometimes there was a rattle, sometimes a roll, but more often a loud harsh *chack' ack ack ack*. One single note had a distinctly flat sound.

The red-bellied apparently nested not far from the cave as during the summer both adults and young were often seen by Giovannoli in the woods near the entrance.

They are birds that make you desire a better acquaintance, that you would like to live near and have a chance to study intimately.

RED-HEADED WOODPECKER: *Melanerpes erythrocephalus* (Linnaeus) [406.]

It was a keen pleasure to find at Mammoth Cave the handsome red, white, and bluish black red-headed woodpecker, a bird beloved by those who have lived in its neighborhood and watched it on its nesting grounds, and whose frequently reiterated *krit-tah-rah, krit-tah-rah* has built up pleasant associations through the long years. Although I saw it a number of times in the vicinity of Mammoth Cave in September, Giovannoli during the summer saw it only in the cultivated valleys east and south along the highways, where he found a number killed by automobiles as too often happens.

From Biological Survey.

Fig. 38.—Red-headed Woodpecker.

Unlike the hairy and pileated, it is found mostly in groves or on fences and telegraph poles in open country. The reason is quickly discovered by watching it on a fence. Down it flies to the ground to pick up a grasshopper or perchance a tobacco or corn worm, for it has been known to eat both; up it flies into the air to waylay a passing insect. In the nutting season if it were followed it might be found picking beechnuts. In some sections, where beech trees are common, good beechnut years mean good redhead years, for the woodpeckers migrate when they cannot get winter food.

In years of plenty, while the nuts are still on the trees, some of the redheads improve their time by storing them away under bark, in holes in trees, or in any suitable crack or cranny. Grasshoppers are stored in the same way, in their season, about a hundred having been found in one crack. These were used later, only a few shriveled ones being left in

February. One unfortunate acorn-storer that George A. Dorsey tells us about in Bird-Lore, after trying several cracks, decided on a bored hole in a telephone pole. But when it had shoved the acorns in, they dropped out on the other side of the pole below, the hole being bored all the way through! The puzzled redhead would chatter agitatedly and hitch around the pole to see what was the matter, but instinct was stronger than reason and before long it would fly off for another acorn. This was kept up until about a double handful lay on the ground.

Many criticisms have been made as to the vegetable food of the redhead, but as Professor Beal wisely remarked, "a person seeing a bird eating his choice fruit, or in some other way inflicting damage, is more impressed by it than by the sight of a hundred of the same species quietly pursuing their ordinary vocations. Thus an occasional act is taken as a characteristic habit." In many cases where birds appreciate too greatly the good things that man would seem to offer in the line of cultivated fruits, their attention can be diverted by planting more of what they often prefer in wild fruits—such as dogwood, mulberry, elderberry, chokecherry, and wild black cherry.

Let us also remember that food is bought for the canary and other house pets and many people buy food for the wild birds, summer and winter, to bring them about their houses. Flowers cost something, too. But without flowers and birds, what would the country be? Before raising his hand against a bird, a man should ask, *what is his fair share?* A man who is unfair to a bird is unfair to himself. It is an honor to the state that, as Funkhouser said, the redhead is "probably the commonest woodpecker in Kentucky."

When a tricolored pair nests in your neighborhood, their family life is found to be a gripping mixture of care-free happiness, devotion, and anxiety for the young. In spring, before the male becomes engrossed in parental duties, he may be found flying around with his mate or signalling her by drumming on a resonant branch or a convenient roof.

A pair that I once had the pleasure of watching, on my first visit to their nest were greatly alarmed. As I noted, one of them leaned far down across a dead limb and in-

spected me, rattling and bowing nervously; the other, woodpecker-wise, stationed itself on the back of a branch over which it peered at me with one eye. Both of them cried *krittah-rah* every time I ventured to take a step. If I were to learn anything, I must retire to an unobtrusive distance. On subsequent visits if, in spite of my precautions, they discovered me, they flew to dead treetops to watch me or startled me with a loud angry *quarr, quarr, quarr* over my head. But when they found that I made no attempt to go near the nest, they finally put up with me and went about their business. When feeding the small nestlings, they would stand under the nest and rouse them by rattling into the hole, so oddly muffling their voices.

When they had finally left the nest, one day I found two birds that may have been father and son on the side of a flag pole, out in the big world together. The old bird's head glowed crimson in the strong sunlight, and it was fortunate indeed that only friends were by.

The strong tricolor makes the redheads such good targets that they are in especial danger from human enemies and need loyal, valiant defenders wherever they live. And what a privilege it is to have birds of such interesting habits and handsome plumage in your neighborhood! How the long country roads are enlivened, how the green fields are lit up, as one of the tricolored birds rises from a fence post and flies over them!

"There's the red-head!" you exclaim exultantly when a loud tattoo beats on your roof in spring. And, "There's the redhead," you cry with delight, when a soft *kikarik* comes from a leafless oak you are passing in winter.

SOUTHERN HAIRY WOODPECKER: *Dryobates villosus auduboni* (Swainson) [393b.]

NORTHERN DOWNY WOODPECKER: *Dryobates pubescens medianus* (Swainson) [394c.]

Six of the most useful members of the woodpecker family were found about the caves during the season, among them the two red-capped black and white ones, the southern hairy

and the smaller downy, differing mainly in size and the markings on the outer tail feathers.

From Biological Survey. L. A. Fuertes.

Fig. 39.—Hairy and Downy Woodpeckers.

The larger hairy, with the louder voice, was less often seen than the downy, with its flat, light note, for the hairy generally keeps to the woods, getting its food mainly from tree trunks and large branches, while the friendly downy, which during July and August was seen or heard by Giovannoli almost every day near Mammoth Cave, gets its food largely from the smaller branches and even the twigs of bushes so that it can range abroad, even into cities, and about the caves characteristically frequented "the scattered trees of the cleared sections" and in September was found near the hotel. As it eats the corn-ear worm or false tobacco budworm, it may occasionally drop down from the bushes into the corn and tobacco fields.

After its early nesting season, the downy was found among the jolly little wandering flocks of chickadees, titmice, and nuthatches, which also are conservators of the forest, spending their days hunting for insects which destroy the leaves, bark, or wood.

This friendly cooperation sometimes dates back to the nesting season, for old nesting holes drilled by the strong-billed woodpeckers are often used by these weaker billed little birds. The amount of work they are saved can well be imagined for, as Forbush tells us, a hairy woodpecker "sometimes spends nearly an hour of hard labor in digging out a single borer"—how much more in excavating a nest!

His excavations do not end with summer, however, for

in cold winter weather he—and the downy too, it is said—sometimes dig out sheltered sleeping places. When looking for winter comforts they may be attracted about houses by suet hung on trees—a thoughtful attention that not only gives pleasure within doors but reflects an appreciative understanding of the good work they do throughout the year.

See Pearson, T. G., Educational Leaflet, 55, Nat. Assoc. Audubon Soc.

EASTERN KINGBIRD: *Tyrannus tyrannus* (Linnaeus) [444.]

The familiar kingbird, with a tip of white on his tail and a concealed orange patch in his crown, like most other fly-catchers dependent on a ready supply of insects, comes north later than the seedeaters and leaves earlier.

From Biological Survey. L. A. Fuertes.

Fig. 40.—Kingbird.

In July and August, Giovannoli saw a few in the cave region at intervals, but most often in July.

An interesting spring migration of kingbirds on the way from their winter home in Central or South America has been recorded from Alabama by Lewis S. Golsan in the Auk. Two individuals were seen on April 10, sixty together on May 3; and three hundred or more in the same place on May 4. The temperature was then 45° F. By May 7, only twenty or thirty were left, and on May 20, only a pair or two.

The kingbird is often complained of as a bee eater, but in 665 stomachs examined by the Biological Survey honey bees were found in only 22, and 51 out of 61 of these were drones. As Prof. Beal in his fly-catcher bulletin says, "When we consider that in the stomachs examined there must have been at

least 10,000, insects and probably three times that number would be nearer the mark, it will at once be seen that the proportion of honey bees in the kingbird's diet is small." McAtee, in "Farm Help," calls attention to the fact that "the rose chafer, a species not only destructive to vegetation but known to be poisonous to chickens and pheasants, is freely taken by the kingbird." Moreover, corn-worms, a variety of tobacco worms, and the spined tobacco bugs are eaten by this friend of the southern farmer.

The kingbird's reputation for a peppery disposition also needs modification. His naturally harsh voice he cannot be blamed for, and his pursuit of intruders upon his home circle has a worthy motive. For nearly two months Olive Thorne Miller, the bird student, once studied a kingbird's nest, "day after day, early and late, in storm and in sunshine," with delightful results, and her testimony is that "with none of the intruders had the kingbird any quarrel when away from his nest."

At home the kingbird, as she says, "united the characters of brave defender and tender lover. To his spouse his manners were charming . . . during the period of sitting . . . the protector of the nest perched every night in a poplar tree across the yard, and promptly at half past four o'clock every morning began his matins. Surprised and interested by an unfamiliar song, I rose one day. . . to trace it home. . . The song was a sweet though simple strain, and it was repeated every morning while his mate was separated from him by her nest duties. . . In the outset. . . the notes seemed hard to get out; they were weak, uncertain, fluttering, as if the singer were practicing something quite new. But as the days went by they grew strong and assured, and at last were a joyous and loud morning greeting."

Mrs. Miller, at that time, many years ago, could find nothing in the books regarding this morning song but since then it has been described by Francis H. Allen in The Auk, and careful studies have been made by others of all the many utterances of the kingbird. They have been classified by Hausman as (1) call notes, (2) alarm notes, (3) chase notes, (4,

victory notes, (5) flight song, and (6) matin song, and offer an interesting field for observation.

See Pearson, T. G., Educational Leaflet 81, Nat. Assoc. Audubon Soc.

NORTHERN CRESTED FLYCATCHER: *Myiarchus crinitus boreus* Bangs [452a.]

The crested, one of the larger flycatchers, about the size of the black and white kingbird, can be recognized on sight by its round crest, gray and sulphur yellow underparts, and the pale reddish brown patches seen on its spread wings and tail.

From Biological Survey. L. A. Fuertes.

Fig. 41.—Crested Flycatcher.

It was often seen by Giovannoli in the woods about Mammoth Cave during July, less often in August. And on September 20, one day later than the last recorded before migration at Bowling Green by Wilson, I was much pleased to hear the characteristic loud and piercing whistle in the open woods near Mammoth Cave Hotel.

While less commonly seen than the kingbird, nesting largely in woodland, it also nests in orchards. Vacant hollows in tree trunk or branch, fence post or rail, deserted woodpecker hole, or even a stovepipe may appeal to its fancy and, on occasion, it will accept a proffered bird box.

Its one desideratum seems to be the cast-off skin of a snake or some cheap substitute. Why a snake skin, of all peculiar nesting materials? The puzzle has aroused psychological speculations that might well surprise the simple-minded builder. Does it hark back to some ancestral association, is it to frighten away small predatory animals by its snake-like suggestion or, as one observer suggested

when finding a piece of rough tissue paper substituted—is it the ominous rustle that protects the nest or pleases the builder?

A suitable form of bird house—a piece of hollow fence post—nailed to the side of the house, by attracting a pair of crested flycatchers afforded John A. Gillespie an interesting and thorough study of a family from behind a window not five feet from the nest. They were under observation from the time when a piece of waxed paper was brought to the entrance as a substitute for the proper snake skin that replaced it later, on through incubation, hatching, feeding, and banding of the nestlings until their first flights were made. These initial flights, made "in a direct and unwavering manner" and in the case of one fledgling covering a distance of at least seventy-five feet, are called by Gillespie typical of a bird "dependent on its wings for food" as contrasted with those of robins and catbirds, largely ground-feeding birds whose initial flights are usually uncertain and of limited distances.

Like the kingbird, the crested flycatcher has what Francis H. Allen says, "speaking ornithologically, we must call a genuine song."

EASTERN PHOEBE: *Sayornis phoebe* (Latham) [456.]

The familiar phoebe of the Mammoth Cave region, easily recognized by its frequent repetition of its name, is an exception to the rule among small birds that insect eaters go north in spring later than the seedeaters. But this is interestingly explained by Dr. Wetmore who states in "Migrations of Birds" that "usually its arrival comes shortly after swarms of hardy stone-flies begin to emerge from the larval state in which they have lived through the winter beneath waters of streams, and fly about, or gather on shrubs, trees, and stones near the water, where they furnish a food supply." The phoebe migrates so early that its eggs have been reported from Nelson County by March 29, and young two days old on April 14.

The phoebes, building their nests largely of mud under

their moss covering, must needs have substantial supports for them and these they find in the rocky mouths of caves, from which they also have unobstructed outlooks for passing insects. In the cave region they might well be called cave birds. Nests of the year were found by Mr. Bailey over the entrances to Mammoth and Dixon Caves, and at Colossal Cave, where a bird was seen near the nest and two broods were said to have been raised. At the outlet of Mammoth Cave above Green River Mr. Bailey found four more nests. On his trip down Green River to Bat Cave on September 28, he observed several phoebes, mostly about caves and cliffs. In the Dixon Cave nest, on July 6, Giovannoli had found "three young just getting feathers."

Fortunately the Mammoth Cave birds do not suffer from an excess of electric light, but an interesting case is recorded by Frederick C. Lincoln in the 1926 Auk, in which an unwise phoebe built her nest within five feet of an electric light that burned to a late hour. Many night-flying moths were attracted by the light and "the young were kept literally stuffed with moths, the parents frequently continuing feeding as late as midnight." The result of this abnormal stuffing process was that the young "died when they were about half fledged." Professor Beal states that among the injurious beetles captured by the phoebe in its normal daylight insect catching, are the cotton-boll weevil, strawberry weevil, corn-leaf beetles, and two cucumber beetles.

From Biological Survey.

Fig. 42.—Phoebe.

The phoebe's nest, because so often built on a piazza where it can be watched at close range, offers unusual

opportunities for enlightening studies both of bird family life and bird psychology.

See Pearson, T. G., Educational Leaflet 93, Nat. Assoc. Audubon Soc.

ACADIAN FLYCATCHER: *Empidonax virescens* (Vieillot) [465.]

One of the small olive-green flycatchers difficult to identify by plumage in the field, the woodland Acadian, with conspicuous wing bars, may be known by its calls, well described in Doctor Chapman's "Handbook." "The most common is a single *spee* or *peet*, repeated at short intervals and accompanied by a rapid twitching of the tail. A more peculiar note is a louder *pee-e-yuk*. The bird seems to articulate this note with difficulty, with bill pointed upward and wings trembling like a fledgling begging for food."

Several pairs of Acadians, Giovannoli says, must have nested in the wooded gulch between the entrance to Mammoth Cave and Green River. They were rather tame and unafraid and could be seen in the lower limbs of the trees at any time of day, catching insects and calling.

EASTERN WOOD PEWEE: *Myiochanes virens* (Linnaeus) [461.]

Two common flycatchers of the Mammoth Cave region, the phoebe and wood pewee, are similar enough in plumage to be confused, but in the phoebe the crown is much darker than the back and the bill is wholly black, while in the wood pewee the lower half is yellowish or brownish. In appearance the two birds are easily distinguished, the fluffy, often untidy-looking phoebe, sitting carelessly with wings drooping while the wood pewee, trim and slender stands on its perch erect as an officer on duty. The same differences are shown in the nests of the two, that of the phoebe being wide and seemingly loosely constructed, as if thrown together; that of the wood pewee being a narrow cup saddled onto a branch and artistically decorated with lichen.

The characteristic voices of the two are even more distinct, that of the phoebe being the plain utterance of a lovable but workaday person; that of the wood pewee

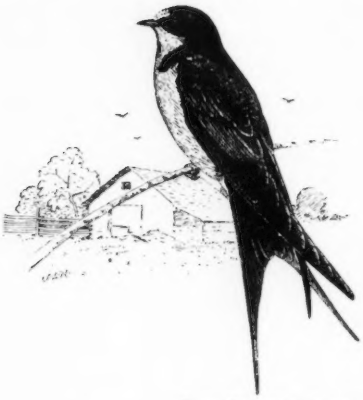
musical, dreamy, poetical as in soliloquy, and of such remarkable musical character that its many variations have been studied elaborately and recorded in musical notation. As Aretas A. Saunders in his handbook of Bird Song says, one of the most interesting of all bird songs is the twilight song of the wood pewee. "The lover of bird music who has never heard this song will be well repaid for his effort if he reaches the haunt of a wood pewee some morning before daylight in late June or July, for the complete song cannot be heard at any other time." The song seems divided into "groups of rhythmically arranged phrases and suggests, as Henry Oldys some years ago pointed out, the arrangement of many well-known tunes in human music." Though simple in utterance it "is of high rank in musical form."

At Mammoth Cave during July and August, Giovannoli reports, "every bit of woods had its pewee. They are to be heard and seen every day, often on the hotel grounds." They were also heard at the caves on September 17 and 18, and at Great Onyx as late as September 24. Although no remarkable song was heard there, they were among the few birds it was especially pleasing to hear carrying singing hearts into late September.

BARN SWALLOW: *Hirundo erythrogastra* Boddaert [613.]

The long forked tail of the barn swallow identifies all but the young, even when the steel blue of the upperparts and the rufous of forehead, throat, and chest cannot be seen.

In 1909 several pairs were found by Howell nesting about the Mammoth Cave hotel buildings where they could do much good by destroying annoying flies and mosquitoes, but in 1929 none were seen by Mr. Giovannoli in the cave region except about seven miles east of Mammoth. He explains, however, that the birds were probably more common than these records would indicate. At Bowling Green (1912 to 1921), Gordon Wilson found them fairly common, commoner in the migrations.



From Biological Survey.

Fig. 43.—Barn Swallow.

Preparatory to their fall migrations the barn swallows join with other swallows—the eave, the bank, and the tree—in the roosts in reeds and water plants. In Maine I have known them to roost in the arrow-shaped leaves of the pickerel weed whose trough-like surfaces afforded good resting places. One roost after discovery the middle of July lasted about a month. In Virginia the barn swallow flocks gather by July 20.

Of the sixty-six kinds of birds known to feed on the cotton-boll weevil, McAtee, in "Farm Help," states that probably the most effective are the orioles, which remove the weevils from the buds of the cotton plants, and "the swallows, which feed upon the weevils when in flight, seeking to extend their range."

But aside from its value as a destroyer of insect pests, as a familiar friend of the farm and a bird of beauty and graceful sweeping flight, the barn swallow can ill be spared from the home or the highway.

PURPLE MARTIN: *Progne subis subis* (Linnaeus) [611.]

It is good to know that the delightful purple martins, favorite birds of the south, nest in boxes built to attract them in the neighborhood of Mammoth Cave. During their fall migrations they are abundant in the region. On July 30 Giovannoli counted twenty resting on the branches of a dead tree and after that he witnessed three large flights at Cave City—the first on July 21; the second, a larger flight on August 1; and the third on the evening of August 16, when "hundreds if not thousands were flying over the town and streaming out to ponds where they seemed to be drinking as well as feeding on the wing."

On these dates they were doubtless gathering to migration roosts, of which there are many in the south. A graphic account of a St. Louis roost in a willow thicket on the Mississippi has been published from the diary of the ornithologist Otto Widmann. In the city of Washington for many years there has been a remarkable roost which has been described from time to time in Bird-Lore. At its height it was estimated to contain forty thousand birds, when they were in elms over a street car line near the capitol.

In Alabama, where Arthur H. Howell has found roosts, he says the martins are "well known and universally beloved. Practically every farmyard has some provision for these birds in the way of nesting boxes, and even the rustic cabins of the negro field hands are not without their string of hollow gourds hung on a pole . . . a practice [Philip H.] Gosse tells us, learned from the Indians."

Those who wish to put up suitable nesting boxes for the martins will be interested in an article on martins and martin houses by Thomas H. Whitney in the Wilson Bulletin. In this he urges that the houses should be made of "inch lumber, carefully joined and with a substantial roof, covered with tin or copper," as houses made of thinner boards "become veritable infernos on a hot summer day." The English sparrow is a serious menace to the martins and whoever puts up houses to attract martins should accept the responsibility of protecting them from their enemies. As Whitney says, "the community life of a martin colony is the source of endless interest, with quarrels and courting, and family disputes just as we higher beings have."

NORTHERN BLUE JAY: *Cyanocitta cristata cristata* (Linnaeus)
[477.]

The handsome, well-known blue jays are among the commonest birds at Mammoth Cave, dashing around, calling loudly near the entrance, on the hotel grounds, about houses, and in the woods.

Their bad reputation among their small neighbors is not without foundation when they are looking for food for their young, but at other times of year their diet has much to recommend them, including such injurious insects as false to-

bacco budworm, corn-ear worm, fruit-eating beetles, grasshoppers and caterpillars (many of them the large hairy ones); and in winter hibernating insects and their eggs. Acorns and small nuts are also favorite foods and one of their good habits, to which Forbush, in Birds of Massachusetts, calls attention is that of burying "nuts and seeds in the ground, thus planting forests. They also regurgitate smaller seeds and so distribute them."

From Biological Survey.

Fig. 44.—Blue Jay.

In regions where small nuts and acorns are not plentiful, the jays in fall and winter go to better feeding grounds. Besides their autumnal wandering for food they, like certain other supposedly resident birds that winter where they breed, as Doctor Wetmore in "Migrations" points out, though present in most of their range throughout the year migrate from the northern part of their range, so that the "individuals seen in winter are not always the same as those observed during summer." Flocks of from fifty to a hundred have often been seen, the fearless birds migrating by day and flying as low as fifty to a hundred and fifty yards from the earth.

Where the jays spend the winter and are dependent on an artificial water supply, the interesting experiences of Mrs. H. S. Benedict are worth remembering. Instead of storing her bird bath, she left it out all winter, as she tells us, "even on days when it was eight or ten degrees above zero. If the cake of ice was not removed from the bath by 11 a. m., the jays sat in a tree above the fountain and called until I appeared with the teakettle to thaw the ice and refill the bath." One jay was seen to "immerse himself sixteen times in rapid succession before he would fly into the tree to preen himself."

SOUTHERN CROW: *Corvus brachyrhynchos paulus* Howell
[488c.]

About Mammoth Cave, Giovannoli reported, "crows are uncommonly rare. During two months, July and August, only seven were seen, three the most at any one time. One was seen dead, shot in a corn field, which may furnish a clew as to why they are so uncommon." As Edwin R. Kalmbach of the Biological Survey states in his Farmers' Bulletin on the Crow in Its Relation to Agriculture, the crow "is capable of doing both serious harm and extensive good" and hasty judgment on its worth should not be rendered, lest it "be persecuted in sections where it is actually aiding the farmer." Indiscriminate killing is not warranted.

Much of its damage to crops and poultry can be prevented, while its services in the control of insect pests can ill be spared. In Kentucky, the fact that it destroys some of the worst insect enemies of the tobacco and corn crops is not to be forgotten.

To prevent its damage to corn and other grains, the wet seeds can be soaked in coal tar and then thoroughly dried before planting. Grain may also be scattered over fields where the crop is just sprouting. To protect poultry yards a network of twine may be stretched from poles across the fields. The various familiar frightening devices may help, especially hanging dead bodies of crows in conspicuous places.

Aside from the question of its local economic status, the crow is such an unusually intelligent bird that it merits first-hand study. It has even been said that "if men could be feathered and provided with wings, very few would be clever enough to be crows!"

But sometimes a more clever antagonist may outwit one. An amusing hawk and crow episode is related by Philip L. Martin in the 1929 Bird-Lore, illustrated with a droll, convincing diagram. About a dozen loudly cawing crows were engaged in chasing a big red-tailed hawk with their customary persistence. Finally the leading crow was directly over the hawk, apparently trying to strike it. On the instant, with dramatic suddenness, the redtail turned

upside down, "reached up with its sharp claws, and grabbed the crow."

That crows have a language, Doctor Chapman assures us, no one who has listened to them can doubt. But as he asks, who can translate it?

A good place to study crow choruses would be at one of the remarkable winter crow roosts, a hundred and seventy of which in the United States have been mapped by Kalmbach in the 1916 Yearbook of Agriculture. Four were found in Kentucky in the winter of 1911-1912, three others being located by Wilson near Bowling Green in 1922. "In many respects," Kalmbach says, "our crow roosts present the most wonderful of bird phenomena still taking place in the thickly settled Eastern and Central States." They even suggest the historic gatherings of myriads of passenger pigeons. His vivid description of them is thrilling to the bird student.

In the short days of winter, the crows begin gathering early in the afternoon, straggling along for miles in irregular lines converging to a focus. Not until sunset or after, Kalmbach says, is there an indication that the destination is near. "Then the low-flying horde, producing a distinctly audible silken rustle with its many beating wings, approaches a certain heavily wooded area over the center of which hovers a hazy, cloudlike mass—a countless, gnat-like swarm of clamorous crows." As they finally alight, "the formerly bare branches of hickories, oaks, and chestnuts strain heavily with the weight of closely perched birds. Occasionally an overladen branch cracks, scattering its load of startled crows, which rise, add their calls to the now deafening roar above, and join in the whirling rabble to seek new resting places."

In a Massachusetts roost studied by Doctor Townsend in the winter months between November and February, when the roost was unoccupied during the day he picked up several hundred pellets ejected by the birds after a meal and composed of its useless and indigestible parts. The contents of these were examined by Kalmbach and the result given in Townsend's article in the Auk for 1918.

CAROLINA CHICKADEE: *Penthestes carolinensis carolinensis* (Audubon) [736.]

The Carolina chickadee is common in the cave region, as Giovannoli says, "not only in the woods but about the yards of houses where there are trees."

Chickadees, nuthatches, and tufted titmice all nest

From Biological Survey.

Fig. 45.—Chickadee.

early in protecting holes in stubs and trees and when the nesting season is over go about in small mixed flocks wandering at will to glean where they may.

To those whose ears are accustomed to the *phoe-be* note of the black-capped chickadee of the north—a larger bird with more white on wings and tail—reported by Mr. Funkhouser as a rare winter visitant in Woodford County, the note of the Carolina is surprisingly different. It is an oddly accented little strain—*car-o'-li-nah'* or, as Doctor Chapman renders it, "*my-watchee-key.*"

A defense note of the Carolina chickadee at the nest—an "explosive hiss"—has been compared by Andrew L. Pickens to the hiss of the copperhead snake, and he gives a drawing showing the peculiar muscular efforts by which it is made.

A winter window shelf may easily be made attractive to the lovely chickadees by the daily offer of crumbs and chopped suet.

TUFTED TITMOUSE: *Baeolophus bicolor* (Linnaeus) [731.]

The gray tufted titmouse, as Giovannoli reports, while not so common as the Carolina chickadee with which it is often associated in the Mammoth Cave region, was generally heard on every walk into the woods and was occasionally seen about the hotel.

From Biological Survey.
Fig. 46.
Tufted Titmouse.

It is one of the many birds that utilize old woodpecker holes for nests, and its use of cattle hair for lining is well known. It is, however, a surprise to hear from Ward Reed's account that a pair of titmice were once caught red-handed near a woodchuck, one of them with its bill already full of hair, the other bobbing up and down plucking hair from the poor woodchuck's back!

The titmouse is one of the three birds of the southern woods whose songs are sometimes confused, but by careful listening to a full repertoire they can readily be distinguished. The single syllabled though long-drawn *cue, cue, cue* of the red cardinal, taken in connection with his spirited whistles, stands quite apart from the two-syllabled *pe-to, pe-to, pe-to* or *pe-ter, pe-ter, pe-ter* of the gray titmouse, and the three-syllabled *tea-ket-tle, tea-ket-tle, tea-ket-tle* of the brown Carolina wren.

Like the cardinal and wren and many other song birds, the tomtit, as he is endearingly known, besides his song, as occasion demands, runs a long gamut of small talk, whose significance I have tried to suggest in the titmouse leaflet. It is best heard at the nest, where it may include the infantile, lisping notes of the hungry brooding bird coaxing her mate to feed her; the tender note of her mate calling her to come to the door for the food he has brought; pretty conjugal

notes of greeting and farewell; the chattering scold and cries of anger, anxiety, or terror heard when enemies threaten; sharp notes of warning to the young, and wails of grief when harm has come to them. Such notes, given emphasis by vivacious, eloquent movements and gestures, interpret the thoughts and feelings of these intense little feathered folks almost as clearly as elaborate conversations do the emotions of less demonstrative human beings.

See Bailey, F. M., Educational Leaflet 71, Nat. Assoc. Audubon Soc.; Pickens, A. L., Attracting Birds in the Southeastern States, Bird-Lore, vol. 28, pp. 102-107, 1926.

WHITE-BREASTED NUTHATCH: *Sitta carolinensis carolinensis* Latham [727.]

The quaint bob-tailed, blue-gray, white-breasted nut-hatch, or "head-down bird," as it is called from its odd habit of walking straight down the side of a tree trunk, is one of the pleasantly familiar birds of the cave region. In summer, as Giovannoli says, "it is to be seen and heard in the woods and on the hotel grounds any hour of the day," rarely less than two and often more being seen at once, and these frequently being found in company with chickadees and tufted titmice.

The white-breasted nuthatch is cited by Doctor Wetmore in his Migration of Birds, as "an excellent

From Biological Survey.

Fig. 47.—White-breasted Nuthatch and Downy Woodpecker.

illustration of slight migratory movement among individual birds of resident species," but he adds that "the winter immigrants may be determined only through banded individuals," which suggests an interesting field for bird banders.

In winter the nuthatches are especially useful, assiduously extracting the eggs and larvae of injurious insects from crevices in the bark.

But to the casual woodland stroller these small birds are especially endeared by their playful, droll ways, their sweet family life, and their many notes with woodsy suggestions. The soft *yang, yang, yang* and nasal *henk-ah, henk-ah, henk-ah* fall soothingly upon the ear, but there is also a rapid *yah-ha-hah, yah-ha-hah, yah-ha-hah, yah-ha-hah* that I have heard both in June and January.

See Allen, A. A., Bird-Lore, vol. 31, pp. 423-431, 1929.

BEWICK'S WREN: *Thryomanes bewicki bewicki* (Audubon) [719.]

Of the two common wrens of Mammoth Cave, both having light stripes over the eye, the smaller Bewick is dull cinnamon-brown contrasting conveniently with the bright rusty-brown of the Carolina; and moreover the long tail of the Bewick, held over its back as it clambers around, shows a conspicuous white border.

Through July and August, though rarely seen elsewhere, Giovannoli says the Bewick's songs were heard and they were seen commonly on the hotel grounds, sometimes several being in sight at once.

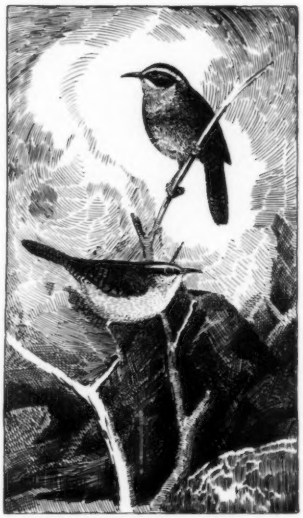
Their usual song is sweet, melodious, and finely modulated, sometimes suggesting that of the song sparrow; but another form is often "clear and bold." They have also a variety of harsh strident call notes.

They are among the easiest birds to be attracted about the house for they will build in almost any possible nook or cranny, even a quart can tacked up in an outbuilding suiting them admirably.

CAROLINA WREN: *Thryothorus ludovicianus ludovicianus* (Latham) [718.]

Abundant in the cave region, the rusty brown Carolina wren is found, as Giovannoli says, in the woods everywhere, on woodpiles in peoples' yards, and about houses and gardens. "Hardly one hour of the day passes but that his cheerful song is heard." During the latter half of September his bright notes stood out strikingly against the background of silence. For the Carolina seems most of all the bird of the cheery heart, singing with animation and charm in happy defiance of the almanac.

Most often he pleases you with a thin high-pitched musical outburst—a three-syllabled *tea-ket-tle, tea-ket-tle, tea-ket-tle;* at other times he surprises you with a rapidly repeated *turrrrr* of throaty guttural quality, given perhaps from a high branch before flying down to the upturned root of a tree that offers good hunting ground. As late as November 18, two were heard by Mr. Bailey in a Cave City back yard, singing vigorously.



From Biological Survey.

Fig. 48.—Carolina Wren.

The pleasure afforded by the presence of the Carolinas is not interrupted by migration, for their food may normally be found in winter by hunting "under fallen leaves and in crevices about logs, sticks, and stones." But where heavy snows come and remain for several weeks they are in serious trouble. Indeed, as Doctor Wetmore states in "Bird Migrations," "Near the northern limit of their range deep snows periodically reduce them almost to extinction, yet they do not attempt a southward flight to escape."

See Stone, Witmer, Educational Leaflet 50, Nat. Assoc. Audubon Soc.

EASTERN MOCKINGBIRD: *Mimus polyglottos polyglottos* (Linnaeus) [703.]

From Biological Survey.
L. A. Fuertes.
Fig. 49.—Mockingbird.

One of the generally distributed birds of Kentucky in summer and, as Funkhouser says, an occasional winter resident, mockingbirds were rare about Mammoth Cave in July and August. On only three occasions did Giovannoli see or hear one near there. "Near Cave City and along the highway southward a few miles," he says, "they were more commonly seen," being noticed at Horse Cave, Bear Wallow, and along the edges of fields, on fence posts, telephone poles and wires. On September 27 I saw one near Mammoth Onyx, and two days later found two or three singing in Cave City, where on November 18, Mr. Bailey again heard them singing.

The mockingbird, Doctor Townsend tells us in an article in the Auk, on the Mimicry of Voice in Birds, "is the best known and most proficient mimic among our native birds. The famous 'Arnold arboretum mockingbird,' whose songs were studied for several years and described in detail by the late H. W. Wright, has been heard to imitate fifty-five different birds." In one hour, Doctor Townsend heard him imitate twenty-one birds. Included in his repertoire were the songs of the blue jay, robin, flicker, phoebe, song sparrow, crow, kingfisher, bobwhite, barn swallow, Baltimore oriole, bluebird, scarlet tanager, and chewink. "An interesting instance of what appears to be conscious mimicry" in this mockingbird was given Doctor Townsend by Dr. S. C. Brooks. He "was imitating the calls of the killdeer, when a sparrowhawk flew by, and the mimic at once set up the rolling call of this hawk."

An enthusiastic admirer of the mocker, the lamented Bradford Torrey writes, in his delightful spring notes from Tennessee, he is "a born citizen and neighbor. . . . fond of gardens and dooryard trees. . . 'man delights me,' he might say, 'and woman also.' He likes to be listened to, it is pretty certain. . . add to this endearing social quality the splendor and freedom of the mocker's vocal performances, multifarious, sensational, incomparable, by turns entrancing and amusing, and it is easy to understand how he has come to hold a place by himself in Southern sentiment and literature. A city without mockingbirds is only half Southern."

Such an important and beloved bird for Kentucky, the mocker should be protected by all the famous chivalry of a southern state.

In the south, William Brewster has told me, he once had the thrilling experience of listening to a moonlight chorus. A mockingbird that waked first sang till one bird after another roused and joined in, when a full beautiful chorus rang out from around a wide circle, adding the enhancement of rare music to the charm of a southern moonlight night.

See Miller, Olive Thorne, In nesting time, pp. 33-64 (courtship antics and nest).

CATBIRD: *Dumetella carolinensis* (Linnaeus) [704.]

Fortunately for its many friends, the gray, black-capped catbird has a long season in Kentucky. When we reached Mammoth Cave in April we found it mewing in one of its favorite haunts, a thicket of small trees and undergrowth overgrown with vines, near the cave entrance; and here it may well have nested, for in July and August, Giovannoli found that "the birds could always be seen within two hundred feet of the mouth." The distance from the nest to the singing tree or observation post of the male catbird, William H. Mousley, in his interesting studies, found in one instance was twenty yards, while in the Maryland yellow-throat it varied from four, seven,

eight, and ten to eleven yards. Of some thirty birds studied, the average was seventeen yards.

From National Association of Audubon Societies. R. Bruce Horsfall.

Fig. 50.—Catbird.

The catbird, like his near relative, the mockingbird, is a true mimic. Besides this, as Doctor Townsend explains in the 1924 Auk, he "appears to be constantly trying some new combination of notes, and some of his improvisations are very sweet and musical." If, the Doctor says regretfully, "he would suppress his love of bizarre and harsh notes, and of buffoonery and horse-play—for I suspect he has a sense of humor—and would devote himself more continually to his musical repertoire, he would rank among our best singers."

But in any case, the catbird is a prime favorite whose friendliness makes him a most enjoyable garden companion, fully appreciative of a well-filled bird bath. While his normal diet includes such delectable morsels as canker worms, cutworms, wireworms, white grubs, and Japanese beetles that injure the corn and tobacco crops, he is quite ready to accept the proffer of viands new and strange to him. A pair watched by Mrs. H. G. Whittle in Massachusetts nested within three feet of her house and patronized her window shelf generously, actually eating sixty to seventy seeded raisins a day.

When the sun shone hot on the nest the wise mother bird would sit on the rim with wings widespread to shade the young, and when a severe hailstorm came, "with feathers drawn close, bill pointing straight up and eyes shut,

made as good a watershed of herself as possible, while hailstones the size of large peas pelted her unmercifully."

Delightful nest studies of the catbird have been made by Francis H. Herrick, who took successful photographs from his nest blind; and by Raymond S. Deck, who actually took a photograph of the mother bird perched on his right hand, by tripping the shutter with his left.

See Bond, Frank, My Bird Boarders, pp. 15-20, 1933; Stone, Witmer, Educational Leaflet 70, Nat. Assoc. Audubon Soc.

BROWN THRASHER: *Toxostoma rufum* (Linnaeus) [705.]

The pale reddish brown thrasher has a long season at Bowling Green—March 5 to October 13—but in the cave region only a few were noted. Between Cave City and Hidden River Cave, on April 22, a thrasher was seen on one side of the road and a mockingbird on the other, but the third of the jolly trio of cousins, the catbird, was missing. In July and August only two thrashers were seen by Giovannoli, one in the brushy growth of Eden Valley and one near Cave City. On September 28 one flew across Green River ahead of Mr. Bailey's boat, disappearing in rich bottomlands.

From Biological Survey.

Fig. 51.—Brown Thrasher.

Perhaps this scarcity is due to the hearty unguarded way this worthy cousin of the mocker expresses his joy in life. When you hear a sudden loud outpouring you have but to look to the top of a low tree or thicket. There he stands, with head up and tail hanging, shouting at the top

of his lungs. What a jolly rollicking song! As Torrey in "Birds in the Bush" exclaims, "Such range and power of voice; such startling transitions; such endless variety! And withal such boundless enthusiasm and almost incredible endurance!" And to the passer-by it is all free for the listening—the air is full of it. No loudspeaker is required.

Fig. 52.—Robin. From Biological Survey.

While the jubilant songster pours out his "grand improvisation" well compared to a Liszt rhapsody, if you push your intruding form through a patch of blackberry vines you may surprise his mate on her nest, where Torrey saw one, with "all a mother's anxiety in her staring yellow eyes."

SOUTHERN ROBIN: *Turdus migratorius achrusterus* (Batchelder) [761b.]

A number of robins were seen at Mammoth Cave on April 22, one early bird on the nest, its yellow bill showing. In July and August, Giovannoli found the robins common

about houses and also in the woods. On September 19 I saw a molting bird. On September 27, in the grackle roost at Cave City, one tree seemed to be occupied by robins but one bird was heard singing blithely in the main part of the roost in the midst of the grackles. On November 16, Mr. Bailey found them common near Colossal Cavern and in Cave City. At Bowling Green, Wilson found them "abundant in summer, fairly common in winter."

Among the many injurious insects eaten by the robin are those that injure both the tobacco and corn crops. Where cultivated fruit is eaten, wild fruits should be planted about the orchards, as robins, like many birds, prefer wild fruit to cultivated.

Robin roosts in summer, fall, and winter have attracted attention for many years. A fall roost estimated to contain from four thousand to five thousand birds, found in a plum thicket in the confines of Sioux City, Iowa, by William Youngsworth, was described in the Wilson Bulletin. When coming to the roost, the birds came in flocks of a hundred and fifty to two hundred, "showing that they had scattered during the day." They came "flying at a high altitude and would quickly break company and dive down in zigzag fashion to the roost."

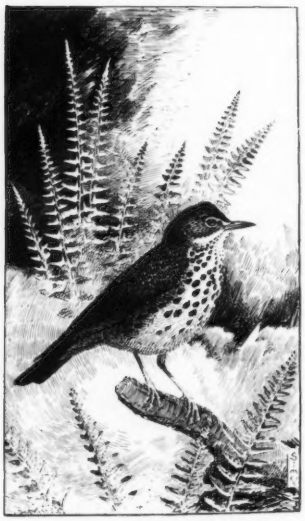
A winter roost is described by Charles R. Wallace in which "thousands of birds spent the winter of 1911-1912."

Remarkable summer roosts, the most interesting of all, have been described by William Brewster in the 1890 Auk and by Bradford Torrey in his "Footpath Way." Brewster's first summer roost was found in 1867. In subsequent studies he estimated 25,000 birds in a roost. Among his many discoveries was the fact that the earlier summer gatherings "are composed chiefly of young birds still in spotted plumage" accompanied by old males in song, who have left their mates brooding their second nests. A family watched by Walter Faxon may be typical.

A father of a family, after feeding the second brood at about 7:30 p. m. "flew to the top of a spruce tree, and, after singing a good night to his wife and babies, took a

direct flight for the roost." Another robin, a model husband and father, distinguished by a peculiar high note in his song, was heard returning to his family at 3:40 a. m. (sunrise 4:29), his arrival being announced by his glad call and morning song. In this way the male robins take care of their younger broods and mates by day, going off nightly to sleep and carry on the education of their older broods. After the second broods are reared, the roosts are augmented by them and their mothers.

WOOD THRUSH: *Hylocichla mustelina* (Gmelin) [755.]



From Biological Survey.

Fig. 53.—Wood Thrush.

At Mammoth Cave, Howell found the brown wood thrushes, with the golden-brown head and large breast spots, common from June 29 to July 5, 1909; and on April 22, 1929, I saw one near the cave. During most of July, Giovannoli reports, they filled the woods with music. They were abundant in the woods, most often where it was thick and damp. Many of them were to be seen in the cool ravine below the mouth of Mammoth Cave. During August they were still frequently seen but not often heard singing. This is the only one of the thrushes found here in summer."

On September 28, wood thrushes and a number of others—including two species not positively identified—which had presumably just arrived on a migration wave, were found near the entrance of the cave in a large dogwood loaded with red berries that they were eating.

See Pearson, G. T., Educational Leaflet 72, Nat. Assoc. Audubon Soc.

EASTERN BLUEBIRD: *Sialia sialis sialis* (Linnaeus) [766.]

The familiar bluebird was rather common in the cave region in the nesting season, Giovannoli found. A pair and young ones were seen in the same spot on the hotel grounds so frequently that the nest must have been close by. On the fourth of July six were counted from an automobile in a ten-and-a-half-mile ride between Mammoth Cave and Cave City, and on the first of September at one time eight were seen drinking and bathing in a spring three feet from the porch of the ticket booth at Crystal Cave.

As with the robin, the list of injurious insects eaten by the bluebird includes those that injure the corn and tobacco crops.

Late in September I saw one swaying as it clung to a magenta polkberry spray and another eating red dogwood berries. As usual, they spent much of their leisure time perching on telephone wires.

The gentle, sweet-voiced birds may often be attracted about the house or yard by nesting boxes. These should be put out before the first of March, Gilbert H. Trafton tells us, and should have the dimensions 12 x 6 x 6 and be put up from 8 to 15 feet from the ground, the entrance hole being only 1½ inches in diameter to keep out martins and blue jays. Not only food but water should be given them in winter when none can be had near by.

BLUE-GRAY GNATCATCHER: *Polioptila caerulea caerulea* (Linnaeus) [751.]

A few blue-gray gnatcatchers were seen, June 29 to July 5, 1909, at Mammoth Cave by Howell, but in July and August, 1929, they were seen there by Giovannoli only three times, a single individual each time, all in young trees on the edge of the woods.

Vivacious, talkative, the jaunty blue-gray, which goes

From Handbook of Western Birds

Fig. 54.—Gnatcatcher.

about with wings hanging, jets his long tail as he flits from branch to branch ready to skip away after some passing insect. *"Tsang"* he calls in an unmistakable nasal as he goes.

Fortunate the person who discovers one of his exquisite lichen-covered nests, as I once did, that of a western cousin, and who has a chance to watch its charming little builders in their home through all their joys and sorrows.

CEDAR WAXWING: *Bombycilla cedrorum* Vieillot [619.]

The beautiful high-crested, fawn-colored, and silken-coated cedar waxwing is recorded from Bowling Green by Gordon Wilson as a common winter resident, staying late

From Handbook of Birds of the Western United States. Ernest Seton.

Fig. 55.—Cedar Waxwing.

in the spring and returning in August—August 17 to June 12.

At Mammoth Cave none were seen by Giovannoli until the end of August, which gave time for characteristically late nesting farther north. Then a restless flock was seen several times near the hotel grounds. During the latter half of September the familiar "beady note" was heard and wandering flocks of from four to perhaps fifty were seen at different points in the region.

Near Onyx Cave, the afternoon that we watched the three chimney swifts apparently hunting for a night's lodging in the dead top of a great hickory rising from a weedy cornfield, we had been watching a large flock of waxwings in the same tree top. They were moving about so continually, some flying down for pokeberries in a bush in the cornfield, some flying up into the air for insects, that it was difficult to count them, though Mr. Bailey finally succeeded in counting forty at one time. A bluebird was also apparently attracted by the pokeberries; a summer tanager, bright red in the afternoon sun, was in the tree top with the waxwings; and the swifts which nonchalantly flew around almost among them added to the confusion and the interest of the hour.

Near Mammoth Cave late one afternoon a small dogwood standing in the bright sunshine, where its scarlet berries showed well, was visited for its berries by both bluebird and waxwing. Then nine of the cedar birds were seen flying around together, and before dark a larger flock swung rapidly over the hotel grounds in close formation with the remarkably timed synchronized movements characteristic of waxwings.

An unusual series of photographs taken at a waxwing nest, showing the young from about thirty-six hours old until the morning of flight, may be found in Herrick's Home Life of Wild Birds.

Those who are interested in the psychology of the use of the crest in birds will find nesting waxwings enlightening teachers.

See Forbush, E. H., Educational Leaflet 48, Nat. Assoc. Audubon Soc.

STARLING: *Sturnus vulgaris vulgaris* Linnaeus [493.]

The European starling, which in summer has a yellow bill and is metallic purplish or greenish, finely spotted with whitish above, may be distinguished from all our other blackbirds by its short tail.

A few were seen by us on September 15 with a flock of grackles on the edge of Cave City, and on September 25, more were seen in a blackbird roost in the town.

Common, familiar birds in Europe, nesting largely in or about buildings, the friendly starlings were so well thought of that, within the last century, many attempts were made to introduce them in other countries. In America the first successful introduction was in April, 1890, when eighty birds were released in Central Park, New York City. Since then they have become thoroughly naturalized in the East, and now occur in every state from the Atlantic to the Mississippi and the bordering western states, and from central Quebec and Ontario, Canada, to the Gulf of Mexico, with sporadic records outside.

From their old homes in Europe and western Asia the starlings migrate in winter as far as northern Africa and India, and in North America, as Miss May T. Cooke says, they are developing migratory habits though they do not settle in definite winter homes. "In the northern part of their range they are largely only summer residents and large flocks can be seen flying south before cold weather sets in." In winter wandering flocks are found well beyond the limits of the breeding range. They breed as far south as Tennessee, Georgia, and South Carolina, and winter in large flocks in central Tennessee with increasing numbers in southern Louisiana, Oklahoma, and Texas. During the fall and winter they often join roosts of grackles and cowbirds.

Their rapidly increasing numbers make their economic status important. Extensive investigations made by the Biological Survey show that their influence when *in moderate numbers* is beneficial, for as Kalmbach and Gabrielson have stated, their pursuit of such pests as the clover-leaf weevil, the Japanese beetle, May beetles, cut-worms, and grass-

hoppers is even more energetic than that of some of our protected native birds.

But they nest largely about buildings and in bird boxes, driving away the native birds that have been attracted to them. The smaller birds, fortunately, can be protected from them, as starlings cannot enter a hole less than an inch and a half in diameter.

From Biological Survey.

Fig. 56.—Starling.

Furthermore, although it is found that the time they spend in destroying crops or in molesting other birds is extremely short compared with the endless hours they spend searching for insects or feeding on wild fruits, that fact does not appeal to people whose favorite birds they have driven away. Their habit of assembling in great roosts, usually in the residential section of a city, also makes them extremely unpopular. In view of all their good and evil possibilities Kalmbach and Gabrielson sanely conclude that absolute protection would seem unjust to both the farmer and the bird lover. The enactment of laws that afford the birds protection except when they are doing or threatening to inflict damage appears to be the wisest procedure.

In the city in winter, where few birds besides English sparrows will come for food, one welcomes the handsome sociable starlings with their cheerful talk and varied mimicry.

In Europe, Dr. Townsend in the 1924 Auk, tells us their "powers of mimicry have been taken advantage of and developed in captivity," where they soon learn "to articulate words and whistle tunes." In the wild state in Europe the starling imitates European birds; in America, American birds.

WHITE-EYED VIREO: *Vireo griseus griseus* (Boddaert) [631.]

The small but self-important white-eye, whose greenlet colors are lightened by white wing bars and touched up by a yellow eye-ring and a yellow wash on his sides, on April 22 was heard near the Mammoth Cave entrance jerking out his gay phrases in just the sort of moist thicket he likes best. In July and August, Giovannoli found him, though not so common as the red-eye, still rather common "both in the woods and in the scattered trees about homes and the hotel near the entrance."

In the latter half of September his loud striking medley was still to be heard from the dense undergrowth, once where a catbird and towhee were also enjoying themselves. Bradford Torrey puts him down as a ventriloquist and he is credited with mimicing many of his neighbors. In striking contrast to the colorless song of the red-eye, his song as Aretas Saunders puts it in "Bird Song," "abounds in explosive consonant sounds." A common phrase suggests *whick-a-tee-wheé-ah* or *chick-a-dee-chick-de-villet*, the Bermuda rendering.

Piquant, self-confident, not to say self-assertive, Whip-Tom-Kelly, as he is familiarly called, on meeting you demands unblushingly "Now, who are you, eh?" But if you render good account of yourself, on acquaintance he will give you his confidence as wholeheartedly as do the rest of the vireos. A brooding father bird that Saunders tells us he once tested for courage kept his seat and picked at the intruding fingers, but when he was ignominously lifted from the nest by his bill, his wrath and courage combined, and on being released he dropped back to the nest and burst out singing "in the excitement of his anger and defiance."

YELLOW-THROATED VIREO: *Vireo flavifrons* Vieillot [628.]

The most highly colored of our eastern vireos, the yellow-throated, which is easily recognized by its bright yellow throat and two white wing bars, evidently breeds in the cave region, though in small numbers. Several were seen there between June 29 and July 5, 1909, by Howell, and on July 6, 1929, one was both heard and seen by Giovannoli in the woods a few hundred yards north of the cave entrance. On August 26 four were seen together on the hotel grounds.

When not seen the yellow-throated can usually be recognized by his song which, in contrast to the soprano of the red-eye, is a loud rich contralto with a unique guttural phrase suggesting *skrig-kig-gig*, sometimes changed to *gig-gig-gig*.

"See me; I'm here; where are you?" Frank Chapman gives as the ordinary song but adds, "sometimes he astonishes us by an intricate liquid trill which suggests the wonderful song of the ruby kinglet, but which unfortunately is sometimes marred by the scolding notes that precede or follow it."

RED-EYED VIREO: *Vireo olivacea* (Linnaeus) [624.]

The small greenlet, the red-eyed vireo with its gray cap bordered by black and white lines, was already singing a little at Mammoth Cave on April 22; and during July and August, Giovannoli reports it was common in all the surrounding woods. As he expressed it, while it was frequently to be seen if looked for, no effort was required to hear it almost any time every day.

From Biological Survey.

Fig. 57.—Red-eyed Vireo.

The cheerful but colorless song is made up of short broken sentences often in triplets. Standing on a branch critically examining the green leaves it would rid of their enemies it seems to ask "where's a worm, where's a caterpillar, where's a worm?" Sometimes it is still more laconic, as quoted by Saunders in "Songs of Birds," saying merely—"Mr. Rich—Mrs. Rich—Mary and Anna." Its complaining call note—*whee-ough*—is such a contrast to the contented song that one wonders at the cause.

Not only cheerful but phenomenally trustful with those that prove themselves worthy, a brooding mother will sometimes let you come near enough to catch the red of her eye when lit by a sunbeam; near enough to examine the exquisite birch bark hanging basket, decorated with cobwebs and maybe bits of gray wasp nest, which cradles her young; and when she has shared with you the happiness of her home she may possibly let you come near enough to feed her or gently stroke her smooth feathers.

BLACK AND WHITE WARBLER: *Mniotilta varia* (Linnaeus) [636.]

The striped black and white warbler, sometimes called the little zebra bird, is a fairly common summer resident at Bowling Green, from March 29 to October 6. At Mammoth Cave, in the wooded ravine near the entrance, one was seen and its thin shrill pipe was heard on April 22. In July it was seen by Giovannoli only four times, three being seen on July 25, and the last on July 31. On September 21 I found it in the woods back of Mammoth Cave Hotel.

An active little bird, its habits are a mixture of nuthatch, creeper, and warbler. Although clambering around tree trunks and branches perfectly at home, as I have said before, "it zigzags back and forth and hops about, turning to peck at every bit of loose bark, promising crotch, or dead tip of a broken branch," for while it creeps about tree trunks so much that it is often called the black and white creeper, there is nothing systematic in its search for insects as there is in that of the brown creeper. And although it often hangs head down, it will not walk down a tree trunk as the nuthatch habitually does. In its song it runs true to warbler form, but even here this individual little bird has its own particular character, and the high pitched wiry *see-see-see-see*, repeated a varying number of times, when heard in the green woods brings a smile of recognition.

One of the merry songsters that I heard on September 21 in the woods back of Mammoth Cave Hotel called my attention to a small but pleasant fall flock, including the Carolina chickadee, white-breasted nuthatch, tufted titmouse, downy woodpecker, black and white creeper, and

redstart, wandering at will through the trees and undergrowth that were brightened by gay touches of autumnal colors.

WORM-EATING WARBLER: *Helmitheros vermivorus* (Gmelin) [639.]

The olive worm-eating warbler, with its distinctive and handsome black-striped crown, was seen by Howell at Mammoth Cave between June 29 and July 5, 1909, and during the first half of July, 1929, was often seen and heard by Giovannoli in the thickets opposite the entrance to the cave, twice being seen in the dry woods above the mouth.

Fig. 58.
Worm-eating Warbler.

When heard some rods away the song reminds one of an insect, but when heard near at hand suggests both the pine-creeping warbler and the chipping sparrow. One that I once heard "sang with his head thrown back and his bill wide open, his drooping tail shaking with the energy of the performance. For some time he sang regularly every ten seconds. He had a definite beat, singing up and down the length of a shallow ravine. As he sang he hunted quietly, hopping down the branches of a tree in ladder fashion, dropping from the tree to the ground; flying up to another tree, and again down to the ground."

He might be confused with the oven-bird in the shadowy woods, but his black crown stripes are quite different from the black-bordered golden crown, and while the oven-bird's song increases in intensity, his fades away toward the end.

BACHMAN'S WARBLER: *Vermivora bachmani* (Audubon) [640]

Of the three records of Bachman's warbler quoted by Funkhouser for Kentucky, two are by Wilson, one from Bowling Green, May 10, 1918, and one from Mammoth Cave, May 11, 1918. At Mammoth Cave he saw five or six Bachman's between the old cave entrance and the ferry-

landing on Green River, and in some cases they let him approach very near them. The bright sunshine made their distinctive marks plainly visible. The third record for Kentucky by George C. Embody, published in the Auk, was from Logan County, about ten miles northeast of Russellville and about fifty miles southwest of Mammoth Cave. Here, in a swamp timbered with tulip, sweet and black gums, sycamore, elms, and various oaks, he found a nest, collected a female, and counted fourteen males. In another swamp he counted eight males.

In case this interesting bird, virtually a lost species for fifty years after Doctor Bachman's discovery of it in 1833, should be found again in the Mammoth Cave region, it should be certainly recognized. Olive green above, yellow below, with *black patches on throat and crown* in the male, without black patches but with the top of the head light gray in the female, it is strikingly and unusually marked. Its song resembles that of the worm-eating warbler and the chipping sparrow, neither of which fortunately live in swamps, but its song to Mr. Brewster seemed nearest that of the parula warbler that nests in wet swampy places, though where the trees are thickly hung with usnea moss. Keen eyes and patient observation are required to discover it for, as Otto Widmann truly remarks: "Its small size, its protective coloration, and its quiet ways combine to make it next to invisible among the heavy foliage of its habitat." At times, Frank Chapman and William Brewster found in Florida, the Bachman's "hung back downward, titmouse-like, as they explored the under surface of a leaf, or, again, they penetrated a bunch of hanging leaves."

In Alabama Arthur H. Howell found that although a lover of timbered swamps, the Bachman is "sometimes found in dry, upland situations."

NORTHERN PARULA WARBLER: *Compsothlypis americana pusilla* (Wilson) [648a.]

Formerly called descriptively the blue yellow-backed warbler, the adult male parula with two conspicuous white

wing bars, when seen from below has another good character, a dusky or coppery patch on the chest.

A specimen taken by Howell at Mammoth Cave on June 30, 1909, is the only record for the cave region. At Bowling Green, Wilson says it is a "rare spring migrant—May 3-19."

Fig. 59.
Parula Warbler.

During migration the northern parula is generally distributed, though preferring deciduous to coniferous trees, but in the breeding season it is found mainly in swampy places where the usnea or beard moss grows, for in this it builds its nest.

Its song, quoted from Gerald Thayer by Doctor Chapman, is characterized by its "beady, buzzy quality," the commonest being a "short unbroken buzz, uttered on an evenly ascending scale and ending abruptly, with a slight accentuation of the final note."

EASTERN YELLOW WARBLER: *Dendroica aestiva aestiva* (Gmelin) [652.]

The yellow warbler, entirely without white markings and with fine reddish brown streaks underneath, a familiar bird of shade trees, lawns, and garden shrubbery, is given by Wilson as a fairly common summer resident at Bowling Green; but during July and August, only two records of it were obtained by Giovannoli in the Mammoth Cave region. A song presumably coming from it was heard on July 1, and one of the birds was seen on August 26, in the grounds of the hotel.

When present it is easily recognized by both markings and song, the song being a simple *wee-chee, chee-chee, cher-wee,* bright and sunny as the summer day.

This cheery little bird is unfortunately one of those most often imposed on by the cowbird. So often, indeed, that it has actually acquired the habit of building a second and even a third nest over the unwelcome eggs.When this is not enough, it is said, four or five are sometimes built.

BLACK-THROATED GREEN WARBLER: *Dendroica virens virens* (Gmelin) [667.]

A migrant in Kentucky, the black-throated green, whose

name suggests his black inverted V throat and green back but does not mention his important yellow cheeks, at Bowling Green is common in the spring and abundant in the fall migration.

As we left before the date of its spring arrival the only records we have for the cave region are for the fall migration when most of those seen were in the dull fall plumage with the black of the throat obscured, but one or two had the rich black throats.

Fig. 60. Black-throated Green Warbler.

On September 19 and 20 they were seen in the red cedars and oaks at Mammoth Cave; on September 22, at Onyx Cave; and September 27 at the small Mammoth Onyx—in a tree over the entrance. The last seen before our departure was on September 28, noted from the Mammoth Cave Hotel piazza.

Seen in the red cedars with the sycamore warblers, one was also discovered in an oak with a redstart. When in pursuit of insects the black-throats dropped through the trees spreading their tails so that the white of the outer feathers showed conspicuously.

They were silent at this time, but when heard in the woods of their nesting grounds, their song readily identifies them. One of the loveliest of all warbler songs, the softly drawled *zee-ee-ee, zee-ah-ee* turns all one's thoughts to quietness in the green woods.

CERULEAN WARBLER: *Dendroica caerulea* (Wilson) [658.]

The first cerulean warbler recorded from the Mammoth Cave region was one heard singing by Arthur H. Howell between June 29 and July 5, 1909, when he was carefully noting the distinctions in warbler songs. In 1929 this pale-blue warbler, white below, with a chain-like line between throat and breast, was seen by Giovannoli on July 12, 13, 21, and 25, near the lower end of the wooded gulch between Mammoth Cave and Green River. It is one of the earliest warblers to start south, reaching the Gulf Coast from July 12 to 29.

As Howell has written, the cerulean warbler "is a lover of heavily timbered river bottoms and moist mountain slopes.

and as it spends most of its time in the very tops of the tallest trees, it is rarely seen unless the observer is particularly looking for it. In migration, however, it often descends to the lower branches. It has a cheerful melodious song, which greatly resembles one of the songs of the parula warbler."

SYCAMORE WARBLER: *Dendroica dominica albilora* Ridgway [663a.]

The Mississippi Valley form of the gray yellow-throated warbler, known as the sycamore warbler, is given by Wilson as a rare summer resident at Bowling Green. For three successive years, 1918-1920, he found a nest in a sycamore near the boat landing.

At Mammoth Cave, on September 19, 1929, I was greatly pleased to discover a few of these beautiful gray warblers with their bright yellow throats and black and white markings on cheeks and sides. They were so like their close relatives the Grace warblers I had just been enjoying in the Grand Canyon country that I was especially glad to see them. They were in the quiet fenced fields beyond the hotel grounds in widely spaced round cedars, whose dense foliage afforded good protection from wind and enemies and apparently supplied abundant food. As they traveled from one dark cedar island to another, when the light was right, by watching for movement within the thick foliage I could locate them, and also pick out their relatives, the black-throated greens, who were in the trees with them. The last Sycamore seen in the cave region was, appropriately enough, hunting in a sycamore. In Illinois, Ridgway found it a bird of the bottomlands "living chiefly in the large sycamore trees along or near water courses."

NORTHERN PRAIRIE WARBLER: *Dendroica discolor discolor* (Vieillot) [673.]

The olive green and yellow prairie warbler, with dark markings on the sides of the head and reddish brown streaks on the back, is mainly a migrant in Kentucky but in some places a summer resident. Bowling Green and Mammoth Cave are two of these. In July and August, Gio-

vannoli found it "not uncommon in the brushy localities," and it was "seen along roadsides and in thickets in old fields in Eden valley just northeast of Mammoth Cave. On July 22 four were seen there together and had the appearance of one family."

Fig. 61.
Prairie Warbler.

When not seen, the little prairie warbler may be detected by its song, a series of nine or more *zees* in ascending scale, given, as Aretas Saunders notes, with head gradually rising as the song ascends. This song of the prairie, as I have said previously, "is one of the most restful of bird songs. It is only a simple ascending scale, as far as note goes; but when listened to on a quiet juniper hillside, its delicious z-y quality, and the reposeful, leisurely way in which each note of the upward scale falls on the ear, make it, to me, one of the choicest of all songs. No hint of the work-a-day hurry and toil is to be found here; for a moment you step aside from the care-worn world procession and stop to listen to the quieting voice of Nature, to whom hurry and striving are unknown.

OVEN-BIRD: *Seiurus aurocapillus* (Linnaeus) [674.]

Fig. 62.—Oven-bird.

The small olive-green oven-bird with its orange-brown crown, a common migrant but rare summer resident of Kentucky, was heard near the Mammoth Cave entrance on April 22, two birds apparently answering each other with their loud crescendo *teach-er teach-er teach-er teach-er,* varied by an admonitory *teach, teach, teach.* During the first half of July, Giovannoli heard their unmistakable calls a number of times "in the wooded hollows near Mammoth Cave and along Green River."

The song, as I have said, seems to come from under your very feet but you may watch for a long time without getting sight of the singer. When you do he will probably be on a branch, down which he walks primly. For, as John

Burroughs expressed it, he is "by far the prettiest pedestrian in the woods."

Though you think you know the golden-crown, you have not realized what manner of bird he is until you have heard his famous love song. It is as if a musician who had been playing scales had suddenly changed to an impassioned rhapsody. His ecstacy carries him off his feet and he flies higher and higher into the air, pouring out his rapturous love song. I have often heard fragments of this song in the stillness of the night when it seems peculiarly poetic.

The nest, to which this is the prelude, is placed on the ground and made of leaves that match those surrounding it so that the "oven," open on one side, might be just a bunch of leaves on top of a small hummock. To watch the little builders at work is one of the rare pleasures open to those who live in their neighborhood.

LOUISIANA WATER-THRUSH:
Seiurus motacilla (Vieillot)
[676.]

The olive-brown Louisiana water-thrush was seen at Mammoth Cave on July 5, 1909, by Howell. On April 22, 1929, I found one near the old entrance singing in a tree almost over the brook that runs down the ravine to Green River. He sang with head thrown back so that even on a high branch the white line over his eye showed conspicuously. He sang his rich brilliant song loudly and continuously as if his nest were near by, and possibly is may have been, for near Washington as early as April 10 one has been found building.

From Biological Survey. Sim.
Fig. 63.
Louisiana Water-Thrush.

When seen walking along the edge of a stream appearing and disappearing as it hunts for insects in the dark earth, the water-thrush may be recognized by the teetering of its body. But I like best to think of it high in a tree top pouring out its fresh spring song with all the joy of homecoming.

KENTUCKY WARBLER: *Oporornis formosus* (Wilson) [677.]

From Biological Survey.

Fig. 64.—Kentucky Warbler.

The beautiful Kentucky warbler, with velvety black throat band affording rich contrast to the brilliant yellow below, was heard near the entrance to Mammoth Cave on April 22, a day after its record arrival at Bowling Green. It was fairly common at the cave, Howell found, from June 29 to July 5, 1909. At Bowling Green, Wilson reported it as rare, giving only one breeding record; and at Mammoth Cave Giovannoli saw it only once, on July 25, when two were noted near the mouth of the cave "in company with a number of other warblers." A nest was seen by Giovannoli in 1925 in Breathitt County.

Here it was in one of its favorite localities for, as Howell says, it is "a lover of moist wooded ravines among the hills." When silent it may easily be overlooked but if discovered on the edge of a clearing, the friendly bird may reward your interest by continuing to walk over the ground and about the base of the tree trunks hunting for insects; or better still by flying up into a low branch and giving its loud unique warbler song—*turdle, turdle, turdle* or *klerwee, klerwee, klerwee, klerwee,* much less suggestive of a warbler song than that of a Carolina wren, for

which it may be mistaken. The song has been happily described by Bradford Torrey, who says, "I now heard this song for the first time, and rejoiced to find it worthy of its beautiful author . . . a succession of clear, sonorous dissyllables, in a fuller voice than most warblers possess, and with no flourish before or after. Like the bird's dress, it was perfect in its simplicity."

MARYLAND YELLOW-THROAT: *Geothlypis trichas trichas* (Linnaeus) [681.]

Fig. 65. Maryland Yellow-throat.

The hardy black-masked Maryland yellow-throat has a long season at Bowling Green, being recorded by Wilson from April 14 to October 29. At Mammoth Cave during the summer Giovannoli says the birds were heard every day and evidently nested in the ravine above the mouth of the cave. They were not uncommon in brushy places, most often where it was damp. Roadside thickets and even ditch banks attract them and they are often met with in passing. Most often it is the little black-mask who stops to take a good look to see what manner of man the passer by may be, while his safely nondescript olive and yellow mate quickly takes to cover.

When not seen, the strikingly accented song of the Maryland places him. *Witchery, witchery, witchery* or *which is it, which is it, which is it,* suggests its familiar syllables. So familiar are they and so completely do they seem to represent him that it is almost startling when he suddenly vaults into midair with an ecstatic love song. "From the rank of a prosaic hunter after worms" he is suddenly raised to that of "an impassioned musician and lover."

In his domestic relations, Montagu Chamberlain has told us "few birds are more affectionate than the yellow-throat, the little black-mask carrying food to his mate on the nest, caressing her, singing to her, and guarding her. If the nest is approached, he alternately scolds and pleads with marked displeasure and anxiety.

See Pearson, T. G., Educational Leaflet 107, Nat. Assoc. Audubon Soc.

YELLOW-BREASTED CHAT: *Icteria virens virens* (Linnaeus) [683.]

Fig. 66. Yellow-breasted Chat.

The large olive-backed, yellow-breasted chat, with white eye ring and throat line, was found June 29-July 5, 1909, by Howell at Mammoth Cave. Early in July, 1929, Giovannoli often heard chats in the valleys near Green River. On July 10, near Crystal Cave, "their calls were heard coming from six different directions at practically the same time." They are much oftener heard than seen, for their home is the heart of a dense thicket and they are past masters in evading the eyes of the curious. But when, moved by resistless emotion, one throws caution to the winds and bursts above the thicket to give his flight song, the long-tried observer stands amazed, repaid a thousand fold for all the many hours of discouragement. With legs dangling and head up, his wings flap up and down, and at each flap the tail also jerks up and down, each jerk bringing out some astonishing phrase. As Bradford Torrey says, he is, when caught "in the midst of a brilliant display of his clownish tricks, ridiculous, indescribable." His talk Percy Algernon Taverner sums up admirably, saying, "he laughs dryly, gurgles derisively, whistles triumphantly, chatters provokingly, and chuckles complacently, all in one breath."

HOODED WARBLER: *Wilsonia citrina* (Boddaert) [684.]

In the thicket at the mouth of Mammoth Cave, on April 22, a bright yellow, black-hooded warbler was seen, its hood cutting the form of the bird's head so that while a striking feature in sunshine, in the woods it melted into the shadows. Between the mouth of the cave and the Green River ferry, on May 11, 1918, a number were seen by Dr. Wilson in bright sunshine.

Recorded mainly as a migrant in Kentucky, though given in the Wilson Bulletin, by Pindar for Fulton County as "a very rare summer habitant," it was found by Howell fairly common at Mammoth Cave, June 29 to July

5, 1909. It is therefore of added interest to hear that Giovannoli, in July and August, 1929, found it "the most common warbler" about the cave, being seen "on the wooded hillsides and just below the mouth of the cave."

Like the oven-bird, the Kentucky warbler, chat, Maryland yellow-throat, and other warblers, it lives near the ground and as it hunts through the undergrowth, dashing from tree to tree trunk and tree trunk to ground, it flashes its white-patched outer tail feathers conspicuously, singing as it goes.

Fig. 67.
Hooded Warbler.

The striking thing about the song is that it is a clear, loud song with a *tune*, quite different from the conventional warbler song. It is spoken of in "Bird Songs" by Saunders as an example of an accented song produced with "certain movements," and he explains that with the introductory notes the head is jerked up and down and, when the high-pitched strongly accented next to the last note is reached, "jerked back until the bill points nearly vertically upward."

AMERICAN REDSTART: *Setophaga ruticilla* (Linnaeus) [687.]

The male redstart is easily recognized by his jet black upperparts lit by salmon patches on breast, wings, and tail; these being replaced in the female by pale yellow patches.

An abundant migrant and fairly common summer resident at Bowling Green, one was seen June 29-July 5, 1909, by Howell at Mammoth Cave. In the summer of 1929, Giovannoli reports, the birds were rarely seen except near the Mammoth Cave ferry, where there was evidently a nest. On July 11 both parents were seen, the female feeding a young one that could fly only weakly.

During the fall migration—on September 19, 20, and 21—in the thick red cedars of the hotel grounds where I had been watching sycamore warblers and black-throated greens, redstarts were found a number of times, though mainly females or immatures—their tails when spread showing yellow.

Among the most active of the warblers, the redstarts careen about madly, opening and shutting their long fan tails, turning somersaults, flitting from branch to branch, stopping a second for a little outburst of song—if it be the season of song—then fluttering around again and suddenly falling through the leaves almost to the ground only to snap up their prey and dart off to begin all over again.

The charming Spanish name of the redstart—Candelita, "the little torch that flashes in the gloomy depths of tropical forests," as Chapman tells us, had always seemed delightful and imaginative to me but I had never realized its truthful appropriateness until with those at Mammoth Cave. Then, a handsome male I was watching gave me a surprise. In dropping down through a tree he seemed to show all his salmon patches combined into the flame of a torch—those on tail, wings, and breast, giving a salmon torch flash! Presumably the black between the patches went in with the tree shadows, so being lost. But whatever the optical explanation, it was a startling and illuminating sight.

When watching warblers with Mrs. Olive Thorne Miller long ago, we happened to witness a curious incident—a widowed redstart being helped with the feeding of her little one, albeit against her will, by a chestnut-sided warbler. Who knows? Perhaps his own home had been broken up.

ENGLISH SPARROW: *Passer domesticus domesticus* (Linnaeus) [688.2.]

"Persistent permanent resident," Funkhouser aptly styles the English sparrow in Kentucky, and Giovannoli reports it as very abundant about the houses and barns of the Mammoth Cave region. The pond above the main entrance, flanked by a cornfield that the sparrows frequented, was evidently most convenient as thirsty squads would fly down to the edge to drink. In the cornfield perhaps they were engaged in destroying insects injurious to the corn crop, as they commonly eat both those and tobacco insects.

In regions where the English sparrow has been estab-

lished the longest its objectionable habits seem to have become modified and it is no longer a dangerous usurper. But in newly invaded regions, in order to make a place for itself among the old established native birds, it still overdoes the matter and well merits the summary justice meted out to it by state laws that deny it protection. It can then be dealt with in various practical ways, as suggested by Ned Dearborn in his bulletin on the English Sparrow as a Pest. But in eastern cities, where it has become better adjusted to its environment and is one of the few winter birds, its cheerful presence may prove welcome, and when watched sympathetically it may be found to have interesting habits.

A late summer roost of English sparrows shared by robins, purple martins, and grackles has been carefully watched by Herbert L. Stoddard for a number of seasons. When the native birds depart for the south and the leaves of the deciduous trees fall, he tells us, the sparrows normally transfer their roost to a number of small sheltering evergreens near by; but in one comparatively mild fall and winter about a thousand of them roosted in small maples and elms, hundreds to a tree top, fully exposed to the cold and wind, suggestive commentary on their hardihood and ability to hold their own in adverse circumstances.

EASTERN MEADOWLARK: *Sturnella magna magna* (Linnaeus) [501.]

In July and August, Giovannoli found the handsome meadowlark, streaked with earth-colors above, black collared and golden below, abundant in the cultivated parts of the county, but not common close to Mammoth Cave, as there is not enough cleared land. In the fields about the new entrance, three miles to the east, he reports, "they were to be seen almost any time." And on September 28, as we drove by, some flew up from these fields. A party of six was also seen on November 16, by Mr. Bailey, in a field near Colossal Cave. Although less common in Kentucky in winter, they are found throughout the year.

And through the year the brown-streaked backs of the birds serve them well, especially at nesting time, for the nest, although made in grass on the ground and often arched over, attracts many prowlers that the mother must turn aside by lying close, trusting to her disguise.

From Handbook of Birds of the Western United States. Ernest Seton.

Fig. 68.—Eastern Meadowlark.

As a striking example of protective and directive coloration the meadowlark can hardly be excelled. The white outer tail feathers, conspicuous in flight, not only make good recognition or directive marks of family value, but actually serve as protective marks, confusing the pursuer when the tail is closed on alighting. The black chest mark, which it has been pointed out it has in common with other birds that sing as they fly overhead, shows from below as do the black wrist marks of certain hawks. When these protective and directive marks are given their full value, what about the golden breast that the ardent suitor turns toward his mate? Living on the ground, the useful meadowlark consumes weed seed in its season, but lives mainly on injurious insects, eating enormous numbers of grasshoppers and crickets.

One of the most interesting characteristics of this delightful bird to the student is the variety of its songs. Saunders, who has made an intensive study of it, at the end of the season of 1922, "had made records of four hundred and seventy-eight different [eastern] meadowlark songs," and in 1929, in his book on "Bird Song," he states that it probably

has thousands of different songs. Birds that sing near each other tend to sing similar songs, he tells us, and variation within individual meadowlarks is so great and "variation between individuals so slight, that recognition of a normal individual meadowlark by its song is impossible."

The meadowlark and song sparrow, he states, "sing more frequently in fall than most species, and by October their songs are often equal to those in spring in loudness, length, and variety." But the meadowlark's flight song, while heard in November, is usually restricted to the courtship season. The intensive work that Saunders has done on the songs of this and many other birds has shown him the difficulties and possibilities of the subject. The scientific study of bird song he says is in its infancy and he urges careful, detailed, and systematic study on the part of many students. For the first need is of good scientific descriptions and accounts of the songs and notes of every species of bird. The geographic variation in bird song makes it important to have records of "dozens or hundreds from each locality."

See Pearson, T. G., Educational Leaflet 3, Nat. Assoc. Audubon Soc.

EASTERN RED-WING: *Agelaius phoeniceus phoeniceus* (Linnaeus) [498.]

The handsome red-wing, with his scarlet epaulettes, was not found by Giovannoli until August 23, "when a number of young and a few adults were seen about a pond on the edge of Cave City," and he was told that they had nested there. The delightful red-wing *o-ka-lees* were heard by me from the same cat-tail pond late in September.

In Fulton County, Doctor Pindar lists them as common summer residents, abundant in migrations. And near Bowling Green, on a three hundred acre temporary lake, Doctor Wilson found thousands roosting during migration.

They are often called marsh blackbirds, as their colonies nest usually in swamps or marshes. The courtship use of the red epaulettes is vividly described by Forbush. The handsome suitors, perching before their chosen mates, "raise the foreparts of the wings well out from the shoulders, bowing with lowered head to show the beauties of their epaulettes, spreading their shining black tails, and pouring forth their

finest music." Some of the males are polygamists, which Forbush explains as being possibly the result of a disparity of the sexes.

From Biological Survey.

Fig. 69.—Red-winged Blackbird.

A successful study of a nest with young was made by Francis H. Herrick from a tent blind on a stranded raft. At first, he tells us, "the birds fluttered around the nest *chucking* and whistling incessantly, but after precisely one hour and twenty-three minutes from the beginning of observations the female came and fed her clamoring young... In the space of four hours on the first day, during which the birds were watched at a distance of about twenty-seven inches, fifty-four visits were made and the young were fed forty times." In the hot part of the day, when trying to protect her young from the sun, the mother would stand with wings spread, bill open, and feathers bristling, and she breathed from a hundred and fifty to a hundred and sixty times a minute. These intimate notes illustrate, as Herrick well says, "the advantage which attends the use of the observation tent."

See Pearson, T. G., Educational Leaflet 25, Nat. Assoc. Audubon Soc.

BALTIMORE ORIOLE: *Icterus galbula* (Linnaeus) [507.]

One of the handsome orange and black Baltimore orioles was heard singing on April 22, in the tall trees of the gulch above the main entrance to Mammoth Cave. Another was seen by Giovannoli on July 12, five miles east of Mammoth Cave, and on August 2, he reports, "one put in his appearance on the Mammoth Cave grounds and for nearly a

month could be heard every morning. On a few occasions, answering calls were heard."

From Biological Survey.
Fig. 70.—Baltimore Oriole.

In September I found a weather-beaten oriole's nest hanging in an oak on the hotel grounds. Its location in a stiff-branched oak instead of a pendulous-branched elm was compensated for by its position near the end of a long branch where small climbing enemies might find unsteady walking and—supposing the brooding mother were to enjoy such refinements—the wind might rock the dexterously hung cradle to her satisfaction. The elaborate weaving of the pendant nest, Mabel Osgood Wright explains in an educational leaflet of the Audubon Society, is done with both bill and claw. Contrary to current rumor that bright-colored materials will be used if offered, she says that although she has "repeatedly hung varicolored bunches of soft twine, carpet-thread, flosses, and the like, on the bark of trees frequented by orioles, with one exception the more somber tints were selected." It would surely be passing strange if, after the safely dull hues with which evolution has endowed the brooding mother, she should go counter to the laws of nature by making her nest a conspicuous mark for prowlers.

The presence of her handsome mate is revealed by flashes of orange and black as he flies from one green treetop to another, but when lost to sight his glad piping whistle tells of his whereabouts. Even his chattering scold is grateful to the ear as a reminder that he is living near, but the musical joyous notes of the summer song are among the real pleasures of the happy season. As for his love song, fortunate indeed is the onlooker who catches sight of the graceful suitor as he bows and scrapes before his lady love

to the rhythm of that tender, exquisitely modulated, and rapturous outburst of devotion.

BRONZED GRACKLE: *Quiscala quisculus aeneus* Ridgway [511b.]

From Biological Survey.

Fig. 71.—Bronzed Grackle.

Close by and in strong sunshine, I have seen the back of the bronzed grackle glint as brassy as a door knocker, marking him as a striking figure of a bird, but at a distance he might well pass as just an ordinary crow blackbird.

In the immediate vicinity of Mammoth Cave in July and August, Giovannoli found the bronzed "conspicuously absent," though "often seen about Cave City and along the highways east of Mammoth Cave in the cultivated sections." In the early breeding season of 1912 at Bowling Green, Gordon Wilson found seventy-five nests in a cedar thicket. A bagworm plague that developed a few years later killed the cedars, and the birds that had found protection in their dense cover left for safer nesting sites.

During the fall migration of 1929 we found great numbers of grackles at Cave City. On the fifteenth of September, late in the afternoon, a large flock was gathering in some trees near the Dixie Highway. When a boy started throwing stones at them, they rose and hid in a cornfield. Following and examining some of the ears of corn, Mr. Bailey found that while a few of the kernels were gone, the destructive corn borers had also disappeared, which may or may not have been the work of the grackles, but they are known to eat the Japanese beetle and a grape insect that injure corn, as well as insects that injure the tobacco crop. To be added to these are other injurious insects, such as cutworms, grasshoppers, and crickets, that make up two-thirds of their insect food. An examination of 2,346 stomachs, as F. E. L. Beal stated in 1900, proves that the grackles are "most emphatically useful birds. . . . This does not mean that they do no harm," he added, "or that they should be permitted to do harm without restraint. . . . The local ravages they commit are usually due to overcrowding in a restricted area, and when this occurs there is no doubt that their numbers should be reduced."

One of the large nightly assemblages of blackbirds was found in Cave City, when we returned from the caves on September 27, the roost being in dense leafy-topped maples on the main residence street near its intersection with the Dixie Highway; and we were told that there had been a fall roost in these same trees or near by ones for a term of years. One of the outlying trees of the roost was apparently given over to robins, but one robin was heard singing blithely from the midst of the blackbirds. At 5:45 p. m. all the birds were seemingly settled for the night.

Two days later—September 29—near sundown, as we looked down the maple vista the top of the green canopy was black with the forms of noisy grackles. But they were then only gathering. When we walked down the street to the roost where we could look across the Dixie Highway to the fields beyond, from low over the grass, long black swirling lines approached to add to the host in the tree tops. But I wanted to watch the roost of the chimney swifts in the school building beyond, so went on,

while my husband watched the grackles. As he tells me, flocks of several hundreds came on in rapid succession adding to the confusion of those rising and flying about and others moving around in the branches trying to get settled for the night. From the street below the chatter and noise were almost deafening. In the roost with the grackles were possibly a few hundred other birds—cowbirds, starlings, and robins, though the robins as far as seen were keeping by themselves. By six o'clock, under a clouded sky, it was fairly dark and the roost had settled down to comparative quiet and rest.

Six weeks later, when Mr. Bailey returned to the cave region to look for hibernating bats, the trees were bare of leaves and the roost abandoned. But in Cave City—November 17 and 18—about a hundred grackles were heard early in the morning in a back yard and perhaps twice as many seen at breakfast time in a pig pen.

See Pearson, T. G., Educational Leaflet 103, Nat. Assoc. Audubon Soc.

EASTERN COWBIRD: *Molothrus ater ater* (Boddaert) [495.]

The small brown-headed, glossy-coated cowbird, well known for the parasitic habit of depositing its eggs in the nests of other birds, was found in the cave region only on September 25, in the Cave City blackbird roost.

At Bowling Green, Gordon Wilson has found it abundant in the fall; Funkhouser gives it as a common summer resident of the state, and says that its eggs are most often found in the nests of the phoebe, yellow-breasted chat, and indigo bunting.

SCARLET TANAGER: *Piranga erythromelas* Vieillot [608.]

The brilliant scarlet tanager, whose black wings and tail set off his glowing color, is mainly a migrant in Kentucky. At Bowling Green, Gordon Wilson has found that it is a rare migrant, a full-plumaged male being rarely seen. In Fulton County, while Doctor Pindar states that it is very rare, he adds that he has seen three males in summer (one in June, 1887, and two in August, 1888), and at least one pair, in the summer of 1893, though no nest was found. In 1909, June 29 to July 5, Howell saw several of these tanagers at Mammoth Cave, and as he had found them breeding in the moun-

tainous parts of northern Alabama, he infers that they were also breeding in the Kentucky cave region.

In the spring migration, on April 22, I repeatedly heard the familiar *chip-chirr* from the tree tops near the entrance. During the summer Giovannoli saw a male scarlet tanager on several occasions —July 7, 12, 14, 20, 21, 27, and August 19—in the woods not more than half a mile from the hotel, and as he suggests, perhaps the same individual. In the fall migration, September 20 and 28, I saw a male in full winter plumage, with black wings and tail and greenish yellow underparts.

From Biological Survey. L. A. Fuertes.
Fig. 72.—Scarlet Tanager.

The change from the conspicuous scarlet coat of summer, which is a comparatively safe livery in the green tree tops, to the inconspicuous olive-green traveling suit, which resembles that of his mate except for its black trimmings, and is donned for his long journey to South America, is one of the marvels of adaptation to need in the plumage of birds.

Between the summer and winter plumages, in the process of molt, the tanager presents a droll, pied appearance, with kaleidoscopic mixtures of red and green. Near the end, perhaps only a scarlet thread or a scarlet spot is left in the green to tell of the gorgeous coat of summer.*

SUMMER TANAGER: *Piranga rubra rubra* (Linnaeus) [610.]

Several of the red summer tanagers, which lack the contrasting black wings and tail of the scarlet tanager, were

* These changes of plumage are figured enlighteningly in a colored plate in Chapman's Handbook, Second Revised Edition, Plate IV, facing page 91.

found at Mammoth Cave from June 29 to July 5, 1909, and in July and August, 1929, Giovannoli reports, the summer tanager was "one of the most conspicuous birds in the woods. His peculiar call was heard all summer, almost constantly during July." This "peculiar call" was given by Alexander Wilson as *chicky-tucky-tuck.*

The only summer tanager that I saw—on September 19—was discovered near the ground, an astonishing bright red spot among the dull colors of the woods. But through the field glass its brownish wings dulled the red. Unlike the scarlet tanager, as Ridgway gives it, "the only seasonal difference of color in this species is the greater intensity of the colors in autumn and winter." But as several years are required for the attainment of the adult male plumage, immature males may be seen in the puzzling mixed red and yellow of their two parents, the proportion of color varying according to age.

Alexander Wilson in his delightfully quaint style says of the summer tanager, "its manners . . . partake very much of those of the flycatchers; for I have frequently observed both male and female, a little before sunset in parts of the forest clear of undergrowth darting after winged insects, and continuing thus engaged till it was almost dark."

EASTERN CARDINAL: *Richmondena cardinalis cardinalis* (Linnaeus) [593.]

Fig. 73.—Cardinal.

Who does not know the cardinal, the crested redbird, hero of James Lane Allen's Kentucky Cardinal? State pride should reinforce all laws for its protection and keep it throughout the state an abundant permanent resident. In the cave region, where it might well appeal to the practical minded by eating tobacco and corn worms, Giovannoli found it only fairly common during July and August, though females especially were often seen about the Mammoth entrance, possibly because there could be little shooting where interested visitors flock. Along Green River

three or four miles below the Mammoth Cave ferry, several were seen late in September by Vernon Bailey.

The rich beautiful song of the cardinal, whether rendered with passionate animation or poetic calm, is familiar enough; but its occasional double notes, the rumor that the female sometimes sings during courtship, and the fact that the male occasionally sings at night may suggest further observation.

As visitors to a bird table, the cardinals offer unusual pleasure, as related in the 1927 Condor by Mrs. Nice, who watched the intimate doings of a pair and their fledgling on her window shelf. "For at least seventeen days after he was full grown" the young one was "partially fed by the adults." For about a week during that time the mother absented herself, apparently to molt in peace, the youngster then attaching himself to the father, teasing for food with apparent success until he too went into retirement. After an absence of sixteen days on the part of the mother and eleven on the part of the father, they returned "in resplendent new plumage." By this time the handsomely feathered young son, who had learned the lesson of independence, had become "the most faithful of patrons at the feeding shelf."

See Dutcher, William, Educational Leaflet 18, Nat. Assoc. Audubon Soc.

ROSE-BREASTED GROSBEAK: *Hedymeles ludovicianus* (Linnaeus) [595.]

The black-coated, rose-breasted grosbeak is given by Doctor Wilson from Bowling Green as a fairly common migrant, April 20 to May 15; September 19 to October 13.

When not seen, the grosbeak may be recognized not only by its characteristic song but by its monosyllabic call note, a thin *eek*, or as Doctor Chapman renders it, "a steely *peek peek*." This call I heard on September 22, in the leafy undergrowth near the Mammoth Cave entrance. I did not see the bird and there is no other record for the cave region, but as the Bowling Green migration dates (September 19 to October 13), include this date (September 22), as the note was heard a number of times, and as, moreover, I have recognized the bird by this note for over forty years, having stated in Birds Through an Opera-Glass, in 1889, that it was as characteristic

as the *chip churr* of the Scarlet Tanager, I feel that it is safe to use the record.

Future visitors to the cave region during the migrations should watch for the bird and remember that the call note is given both by the black-coated male and the large, brown-streaked sparrowy looking female who has a white line over her eye as well as the typical abnormally large grosbeak bill.

See Dutcher, William, Educational Leaflet 20, Nat. Assoc. Audubon Soc.

INDIGO BUNTING: *Passerina cyanea* (Linnaeus) [598.]

A common summer resident at Bowling Green, the indigo bunting is recorded by Wilson from April 21 to October 16. At Mammoth Cave in July, Giovannoli says, the bunting was often seen and heard about the cave though more common where more land was cleared. During August, he reports, the indigoes apparently went somewhere else or became very silent, for they were never heard and only rarely seen.

In looking for the female it should be borne in mind that her back is a soft, unstreaked brown and that by "bearing on hard with the eyes" a suggestion of blue is to be discovered on shoulders and tail. Her habit of jerking her tail from side to side as she perches on weeds or low bushes is also diagnostic, and the family *chip* may be recognized as resembling the smack of the junco.

The small blue-coated male sings from a tree top or on the wing an energetically rendered, insistent roundelay full of sunshine and good cheer. The rhythm of the tree-top song may be suggested by the syllables—*chrit-ty, chrit-ty, chrit-ty, chrit, chrit, chrit, chree; chrit-ty chrit-ty, chrit, chrit, chrit, ta tee; chrit-ty chrit-ty, chrit, chrit, chrit, chrit, chree.*

See Wright, Mabel Osgood, Educational Leaflet 27, Nat. Assoc. Audubon Soc.

EASTERN PURPLE FINCH: *Carpodacus purpureus purpureus* (Gmelin) [517.]

The purple finch, largely suffused with a pretty raspberry or pokeberry color, is recorded for Kentucky by Funkhouser as an uncommon winter resident. At Bowling Green, Wilson in 1922 spoke of it as "formerly a very abundant winter

resident, but for the past three winters almost rare." Its dates he gave as October 16-May 8, and on November 16, 1929, Mr. Bailey found it common in tree tops near Colossal Cavern.

From Handbook of Birds of the Western United States. Ernest Seton.

Fig. 74.—Purple Finch.

As wandering flocks fly overhead their single call note may be heard. In winter, at the Birdcraft Sanctuary of Fairfield, Connecticut, where, Saunders says, the purple finches congregate to eat the abundant sunflower seeds supplied, they "indulge in choruses of song every day in February." At this time they sing a rambling warble but change to "a definite song with a fixed form" on reaching their nesting ground.

The fervid courtship begins in Massachusetts about apple-blossom time, Forbush tells us. Then "the male in his

nuptial antics, clad in his brightest, rosiest plumage, dances erect before the female, facing her with quivering wings fully extended, raised at an angle and vibrating so rapidly that they seem of gauzy texture, and with crown feathers erected, displaying his colors as he swings from side to side about her. Sometimes his excess of ardor carries him up into the air on fast-beating wings, pouring out either soft continuous twitterings or the full, loud, clear mating song, while she usually seems indifferent to his wooing."

See Wright, Mabel Osgood, Educational Leaflet 28, Nat. Assoc. Audubon Soc.

EASTERN GOLDFINCH: *Spinus tristis tristis* (Linnaeus) [529.]

The pretty wild canary, or yellowbird, as the goldfinch is often called, although his yellow body is set off by black cap, wings, and tail, is one of the common birds in Kentucky in summer, and in contrast to sparrows seems a brilliant beauty. In winter small flocks disguised in the dull brownish plumage of the summer female are to be found wandering around looking for weed seeds. In September I saw them about sunflowers, one of their favorite food plants, and occasionally heard their sweet calls as they flew by near Mammoth Cave Hotel or along the roads.

In July and August, Giovannoli reports, goldfinches were seen and heard repeatedly every day about the fields and gardens near Mammoth Cave.

In August these late builders are singing their full summer songs while most birds are silent. I have heard their ecstatic flight song in Maine as late as August 21. Indeed, the happy goldfinch is one of the compensations of August to the bird lover.

Although July and August are their usual nesting months, nests have been found as late as the middle of September, and I have seen fledglings teasing their father for food the last of the month.

Few nests are more delightful to watch, for the home life of the gentle birds is full of charm, as Ernest Thompson Seton has suggested in his sympathetic drawing, well-named Arcadie. Devoted mates, sweet-voiced and beautiful, the goldfinches are among the loveliest of our birds.

Would you have them nest in your yard? You can attract them about you both in summer and winter. To do this, Mabel Osgood Wright advises, "plant sunflowers in your garden, zinnias, and coreopsis; leave a bit of wild grass somewhere . . . . Coax the wild clematis everywhere that it can gain

From Handbook of Birds of the Western United States. Ernest Seton.

Fig. 75.—Goldfinch.

footing; and in winter, when these joyous birds, gathered in flocks, are roving, hard-pressed for food, scatter some sweepings of bird seed about their haunts, repaying in this their silent season, their summer melody."

See Dutcher, William, Educational Leaflet 17, Nat. Assoc. Audubon Soc.

RED-EYED TOWHEE: *Pipilo erythrophthalmus erythrophthalmus* (Linnaeus) [587.]

From Biological Survey.
Fig. 76.—Towhee.

The handsome black and white towhee, or chewink, whose brown sides resemble the dead leaves he is often seen scratching among, is a resident of the state, common in winter. At Mammoth Cave I heard one of the birds singing near the entrance on April 22. During July and August, Giovannoli found them "rather common in the woods and brushy old fields all about the region," and on November 16 Vernon Bailey saw one near Colossal Cavern.

Although rather a shy bird of the underbrush, sometimes hard to locate, the towhee well rewards patient watching. His presence is often announced by his nasal *whank* or *che-wink*, and he sings usually from a fairly low perch, often the top of a bush or low tree.

A good rendering of his ordinary song is given by Ernest Thompson Seton as *"chuck-burr, pill-a-will-a-will-a."* His "territory" song, as Saunders calls it in "Bird Song," is common to birds that have a singing tree or headquarters near their nest from whose territory they drive all other males. Besides the usual songs, Saunders has obtained records of so many unusual songs that he suspects that the towhee "is going through a song evolution, tending toward something better and more complicated than its simple song."

SLATE-COLORED JUNCO: *Junco hyemalis hyemalis* (Linnaeus) [567.]

Winter residents of Kentucky, the slate-colored juncos were not seen until Mr. Bailey's return to the caves on November 16, when he found them common in the brushy woods near the Colossal Caverns.

It is always a pleasure to discover the first flock of these amiable little visitors from the north, for although there is nothing remarkable about them in habit or voice, they lack none of the homely virtues of their kind. After sitting on a brush pile in the sun singing their contented woodsy thrill, or giving the familiar call note that suggests a thin smack of the

lips, they may fly down in your yard, showing the white outer tail feathers that name them, and gather about your door looking expectantly for what you have to offer. Whatever they do, the little gray visitors add greatly to your winter cheer. Among the foods they are likely to choose from a generous window box, Trafton tells us in his book on attracting birds, are nuts, dog biscuit, seeds, cracked corn, crumbs, millet, and suet.

EASTERN CHIPPING SPARROW: *Spizella passerina passerina* (Bechstein) [560.]

The small tame chipping sparrows with reddish brown cap and black bill were common during the summer on the grounds of the Mammoth Cave Hotel and the tourist camp where, as Giovannoli says, they seemed to "feel perfectly at home among the tables, tents, and automobiles." As they are such common birds and destroy not only weed seeds but many insects, including those that injure the tobacco and corn crops, they are of more than casual interest in Kentucky. Though "rather rare" at Bowling Green in winter, they were still commonly seen late in September together with bluebirds, at Mammoth Cave, frequenting the deserted tourist camp and flying up from the ground to perch on the telephone wires overhead.

From Biological Survey.

Fig. 77.—Chipping Sparrow.

Although lacking the charm and attractiveness of the goldfinches, their tameness and domesticity make them pleasant birds of the lawn, and their simple song—*chip chip chip chip*, repeated many times—is a good one to begin with when studying bird songs with Saunders.

The story of a nest in a clematis vine on Doctor Pearson's piazza is interestingly told in an Audubon Educational Leaflet (80). But how about the chippy's nest lining of long hairs? Will the change from horses to automobiles effect a change in their long-established nesting customs?

EASTERN FIELD SPARROW: *Spizella pusilla pusilla* (Wilson) [563.]

The small field sparrow, found at Bowling Green throughout the year though rather rarely in winter, may easily be distinguished from its near relative the little chipping sparrow by its warm color, its bill and back being reddish brown and its breast buffy. It was heard on April 22, singing from the fields above the entrance to Mammoth Cave, and in July and August was found by Giovannoli in practically every cleared area of any considerable extent—in the "open field behind the hotel, on farms in the neighborhood, and abundantly about Crystal Cave north of Mammoth Cave."

When not seen the field sparrow may be recognized by its sweet plaintive voice, which contrasts strikingly with the "dull, unmusical voice" of the chipping sparrow. Its song in the main season of song, as Saunders tells us in "Bird Song," consists of a series of sweet clear notes growing faster and faster till ending in a trill, but late in the summer the time is often reversed, the song "beginning with rapid notes and ending with slow ones." He further states, in the 1922 Auk, that it is not uncommon to find birds that are near neighbors singing exactly or approximately the same song, as is often true with other birds, which supports the theory that "individual birds learn to sing by imitating other individuals."

But while the form of the field sparrow's song is interesting and suggestive, the quality of his song is what we recognize and welcome him by and what we stop for, in the quiet old fields, listening to the minor refrain, with stilled spirits.

For he sings the song of the old fields from a quiet heart, as the wood pewee sings of the green woods, and the thrushes of the shadowy aisles of the forest. As Bradford Torrey said of one he listened to, "the dead could want no sweeter requiem than he was chanting."

WHITE-THROATED SPARROW: *Zonotrichia albicollis* (Gmelin) [558.]

A winter resident in Kentucky, the white-throated sparrow is recorded from Bowling Green by Wilson from September 23 to May 17. A number were seen by me at Mammoth Cave, in the brushy ravine near the entrance, on April 22, before they started for their northern summer home; and on November 16, others that had come south for the winter were seen by Mr. Bailey along the road between Mammoth and Colossal Caves.

In his enlightening book, "The Migration of Birds," Doctor Wetmore, writing in 1926, under the heading The Sense of Direction in Birds, says, "No less wonderful than the fact of migration itself is the regularity and system with which birds pursue journeys that in many cases cover thousands of miles across the earth's surface"; and he goes on to cite the now classic instance of a white-throated sparrow, whose breeding range lies in the northern part of eastern North America, which was caught and banded by Samuel P. Baldwin when on its winter range in Georgia. It was banded on March 5, 1916, with the number 38160. Identified by this band it was again trapped on March 7 and 19, 1917, on several occasions from February 25 to March 22, 1920, and on March 27, 1921, *in each case within a hundred yards of the spot where it was first secured* [italics mine]. "Since this was its winter home," Doctor Wetmore concludes, "we must assume that on each of the years from 1916 to 1921 this bird had migrated north to breed, and had subsequently returned to spend the winter in one particular area of thicket, brush-pile, and open glade in southern Georgia. Such precision of movement impresses one as truly remarkable."

During the winter visit of the white-throat in Dallas, Texas, R. A. Gilliam, a life member of the National Association of Audubon Societies, who has made his fifteen-acre country place a bird sanctuary, usually puts out a ton and a half of grain for the birds, most of it being eaten by the white-throats (Bird-Lore, vol. 31, pp. 439-440). The pleasure of watching this quiet, friendly company and listening to its cheering winter songs doubtless more than repays him for his trouble.

"Old Sam Peabody" or "I. I. Peabody" are given in imitation of the white-throat's clear high whistle, especially grate-

ful to the ear of those who know him on his distant nesting grounds. Another good version comes from Canada, where it nests—*See, see, Can-a-da, Can-a-da.*

See Pearson, T. G., Educational Leaflet 92, Nat. Assoc. Audubon Soc.

EASTERN FOX SPARROW: *Passerella iliaca iliaca* (Merrem) [585.]

The large gray and rufous fox sparrow is given by Funkhouser as "occasionally a winter resident," but from Bowling Green, its nearest reported locality to the caves, Wilson gives it as a rare migrant with dates of February 12 to March 24, and October 13 to November 10. Our only record is a slight extension of the fall date, for one was seen on November 16 by Mr. Bailey between the Mammoth and Colossal Caves.

EASTERN SONG SPARROW: *Melospiza melodia melodia* (Wilson) [581.]

In Kentucky, where it is near the southern boundary of its breeding range, the song sparrow was recorded at the caves only in April and November, by Mr. Bailey, one being seen at the pond above the entrance to Mammoth Cave on April 22, and another heard singing in Cave City on November 17. But as it is a winter resident of the state and may be heard singing in every month of the year, those who know it only in winter may still enjoy its sweet musical songs. Bradford Torrey heard the little optimist on Boston Common caroling with all cheerfulness in the midst of a driving snowstorm!

From Biological Survey.

Fig. 78.—Song Sparrow.

In studying its songs for ten years, Saunders recorded over six hundred variations, but those of an individual numbered only from nine to twenty-four.

IV.—FISHES OF THE CAVES AND CAVE REGION

VERNON BAILEY

The white blind fishes of Mammoth Cave and other caves and subterranean streams and wells of the region have excited widespread interest in the development and adaptations of cavern life and have been given unusual attention. Four species of blind fish have been described and carefully studied, but other species neither blind nor white are found in some of the underground streams, deep in the caves, where they may or may not be indigenous. Some of the guides admitted that fish had been brought in as an added attraction to the tourists and some of the species collected are the same as those found in Green River near by. Since many, if not most, of the caves have direct or occasional water connection with Green River, it would not be strange if some of the local fish had found their way into them and survived for a time at least without any noticeable changes. The mere fact, moreover, of the fish retaining their outdoor colors and patterns would indicate transient or temporary residence in the cave waters.

Specimens of the Miller's thumb, or sculpin (*Cottus bairdii*), were taken by Giovannoli in the Backwater, a pool cut off from Echo River in the bottom of Mammoth Cave, and numbers of little shiners, or silverlings (*Notropis atherinoides*), were taken in Echo River near the boat landing. In Crystal River in the New Entrance section of Mammoth Cave on April 21, 1929, I saw a number of small fish in the water near the boat that resembled small sunfish, perch, and chubs, but did not secure specimens as I was told they had been brought in from outside streams.

The fishes of Green River, a deep navigable branch joining the Ohio River in Henderson County, are practically those of the Lower Mississippi Valley rivers, including many of our most desirable food fishes. There was no attempt to make a thorough collection or to give a complete list of the fishes of the region, but about 29 species were collected by Giovannoli, mostly in the river near the supposed underground exit of the

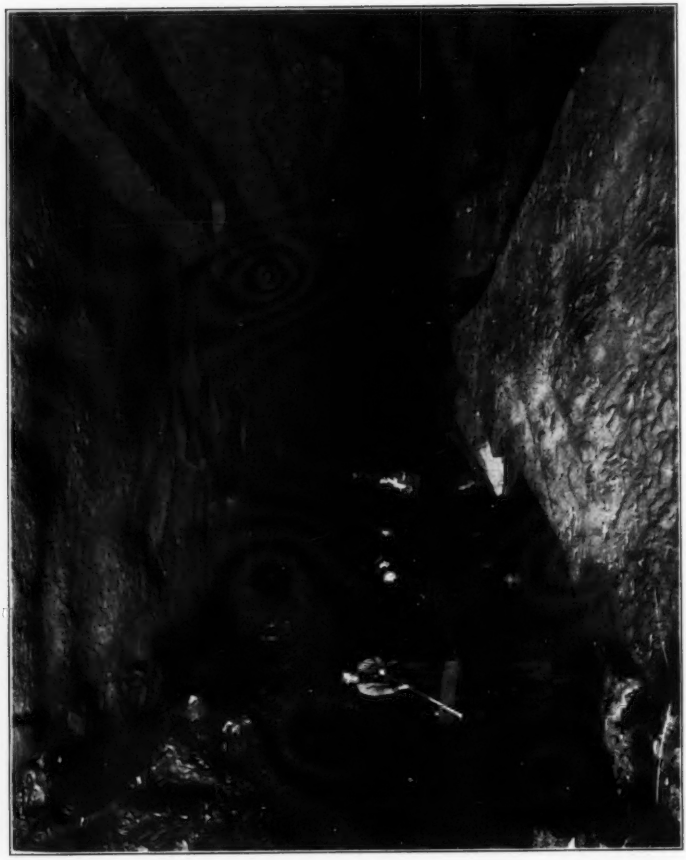


Fig. 79.—Echo River.

waters of Mammoth Cave, and some of the other well-known species are listed. Catfish and fresh-water sheepshead seem to be the commonest catch of the fishermen on the river.

MAMMOTH CAVE BLIND FISH: *Amblyopsis spelaeus* DeKay.

These little colorless, pure white or partly translucent fishes belong to the family Amblyopsidae, the cave fish family, a small group of small fishes mostly blind and more or less

Fig. 80.—Mammoth Cave Blind Fish, *Amblyopsis spelaeus*, white and about 3 to 5 inches long. Mammoth and Rhode's Caves and caves in Ohio, Indiana, and Michigan.

devoid of color, with a very simple alimentary tract, a pouch-like stomach, and simple intestine leading forward to the anal aperture under the throat. This is one of the larger forms of the group, usually two or three inches long but sometimes reaching a length of five inches; and one has been reported as eight inches long. They are rather stout in form, with wide heads and minute rudiments of functionless eyes on top of the head. They have two small ventral fins just in front of the anal fin, which distinguish them from any of the other blind fish of the region.

In simple structure they suggest a primitive type that evolution had overlooked, but in reality they have become highly specialized in adaptation to a primitive environment. In the utter darkness of the deep underground waters they have lost all sense of sight and retain only rudimentary specks of eye tissue without functional nerves, but as compensation they have developed a complex set of terminal papillae and sensory nerves in little rows and ridges over the top and sides of the head and jaws for recognition of food materials and other objects in the water. Like other cave dwellers, from crickets to wood rats, they feel their way, and with few enemies and plenty of time find a real advantage in the absence of

Fig. 79.—Echo River.

light. In their adaptations and structure there is evidence of ancient origin as well as long adaptation to subterranean waters.

They are known to feed upon the eggs and young of crawfish, on other small crustaceans, small minnows of their own and other kinds, insects, worms, and probably on minute vegetable forms found floating in the water.

They were long supposed to be viviparous, as young were on several occasions suddenly found swimming in the water where adult females were kept, but Doctor Eigenmann has shown that the eggs are carried for about twenty-eight days in the gill pouches of the female before they hatch, and the young about a month longer before they come out into the open water. The number of eggs contained in the oviducts of the females at one time ranges from about 70 to 100 and families of 8 to 20 young have been recorded from the gill pouches.

At present these interesting little fishes are scarce in Mammoth Cave, and not one was seen by our party in either Echo River or the River Styx, where they had been previously found. We did not visit the Roaring River farther back in the cave, where they have also been reported. They were never abundant and their present scarcity can probably be in part accounted for by the fact that preserved specimens in bottles are offered for sale at $1.50 to $2 each in many of the curio stores, on curio counters in drug stores and wayside booths of the region. They are caught in little dip nets and preserved for specimens or placed in water to be transferred to other localities.

In Kentucky they are known from Mammoth Cave in Edmonson County, from Rhode's Cave near Corydon in Henderson County, and from north of the Ohio River from numerous caves and deep wells in southern Indiana, Ohio, and Michigan.

AGASSIZ BLIND FISH: *Chologaster agassizii* Putnam

[*Forbesella agassizii* of Jordan's Manual (1929), and his new check list (1930).]

These little pale gray, blind fish were originally described from a specimen taken from a well near Lebanon, Tennessee,

in 1854. They have since been taken in the River Styx in Mammoth Cave, and in subterranean pools in Cedar Sink, several miles from Mammoth Cave. They are generally scarce, very active, and difficult to capture.

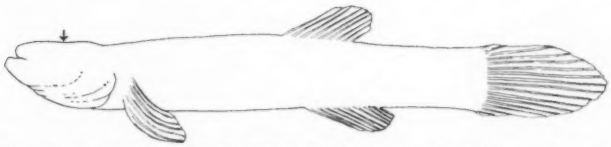


Fig. 81.—Agassiz Blind Fish, *Chologaster agassizii*, pale gray in color, size small. Found in Mammoth Cave, Cedar Sink, and in a well near Lebanon, Tennessee.

They belong to the Amblyopsidae, the same family to which the Mammoth Cave blind fish belong, but are smaller and slenderer, without ventral fins, with sightless eyes less fully atrophied, and with the anal aperture under the throat. In life they are light gray or brownish in color with white belly. In the water they appear whitish and specimens in alcohol soon fade to white.

In habits they seem to be much the same as the other blind fish of the cave, which have a keen sense of vibrations or motions in the water, but no reaction to sound or light except to seek for a dark corner when placed in a lighted aquarium. Even in the darkness of the caves they seem to prefer cover or the seclusion of sheltering rocks or other objects.

LESSER BLIND FISH: *Typhlichthys subterraneus* Girard

Like the Mammoth Cave blind fish, but smaller (about 2 inches long), and without trace of ventral fins. In color they are white or translucent. The sides of the head and jaws are

Fig. 82.—Lesser Blind Fish, *Typhlichthys subterraneus*, whitish in color, about two inches long. Found in Mammoth Cave, and caves near Cave City, Glasgow, and Bowling Green. Also from Tennessee and Alabama.

Photo by Eugene J. Hall.

RIVER STYX IN MAMMOTH CAVE

Fig. 83.—A slightly separated section of the main river channel back of Echo River, but connected in times of high water.

well supplied with rows and ridges of sensitive papillae. The eyes are minute and fully atrophied.

Doctor Girard described this little fish in 1859 from a specimen taken in a well near Bowling Green, Kentucky, and since then they have been found in Mammoth Cave, in a small cave at the edge of Glasgow, and in an underground stream in a small cave at the edge of Cave City. Specimens are also recorded from Lebanon, Tennessee, and Moulton, Alabama.

In September, 1859, Alpheus Hyatt collected seven specimens in Mammoth Cave, and more recently Dr. Carl H. Eigenmann collected them in Roaring River far back in the lower levels of the cave, where they were found swimming freely in open water but more often under large rocks from which they were driven out by merely tapping the rocks with a net handle or the foot. Near Glasgow he found them moderately abundant and captured a few specimens. One was found under a floating board.

HORSE CAVE BLIND FISH: *Typhlichthys osborni* Eigenmann

This is a small white minnow without ventral fins; with minute sightless rudiments of eyes, buried in conspicuous rounded masses of fatty tissue; with cheeks wide and much swollen; and sensitive papillae arranged in numerous rows over the top and sides of the head and jaws.

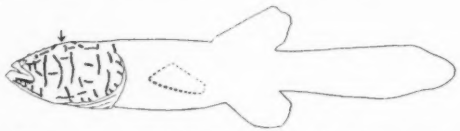


Fig. 84.—Horse Cave Blind Fish, *Typhlichthys osborni*, white in color. A small minnow found in Hidden River Cave and Mitchell's Cave.

These fishes were found by the discoverer, Doctor Eigenmann, in a small branch of Hidden River above the dam in Hidden River Cave, in the town of Horse Cave, Kentucky. In a shallow pool with muddy bottom he found them abundant on his first visit but later in the fall of 1907 could find none in this stream.

On our visit to the cave in September, 1929, some small white fishes were seen in a quiet place in the main river be-

low the broken dam but no specimens were secured. Our guide said they were often caught and given to visiting tourists and a few were shown in jars in the cave office.

Two other species of fish, not blind nor specially modified for cave life, the Miller's thumb (*Cottus bairdii*) and a little shiner (*Notropis atherinoides*), were collected in Mammoth Cave and also in Green River from which they had probably made their way into the lower cave waters.

The following is a partial list of the fishes of Green River in the cave region, mostly collected by Giovannoli near the supposed exit of Mammoth Cave waters. The specimens were identified by Barton A. Bean of the United States National Museum.

AMERICAN EEL: *Anguilla bostoniensis* (Le Sueur)
Large eels were seen by Giovannoli that had been caught on trot lines by Green River fishermen, who report them as fairly common. One small specimen was preserved.

LONG-NOSED GAR: *Lepisosteus osseus* (Linnaeus)
Specimens were collected in Green River, where fishermen report them as common.

SOUTHERN MOON EYE: *Hiodon tergisus* Le Sueur
Specimens collected in Green River, near the entrance to Mammoth Cave.

SMALL-MOUTH BUFFALO FISH: *Ictiobus bubalus* (Rafinesque)
Said by fishermen to be one of the common fish of Green River taken in their fish traps and nets.

RIVER CARP: *Carpiodes carpio* (Rafinesque)
Said to be one of the common fishes of Green River.

HOG SUCKER: *Hypentelium nigricans* (Le Sueur)
Reported in Green River and 5 specimens collected.

STRIPED SUCKER: *Minytrema melanops* (Rafinesque)
One collected in Green River near the entrance of Mammoth Cave.

RED-HORSE SUCKER: *Moxostoma breviceps* (Cope)
Six specimens of these suckers were collected in Green River where they are said to be one of the common food fishes.

RED-BELLIED DACE: *Chrosomus erythrogaster* Rafinesque
Eight specimens were collected in Green River.

SPOTTED SHINER: *Erimystax dissimilis* (Kirtland)
Specimens were collected in Green River.

MINNOW; DACE: *Hybopsis hyostomus* (Gilbert)
Specimens were collected in Green River.

STORER'S CHUB: *Erinemus storerianus* (Kirtland)
Specimens were collected in Green River.

SILVERLINGS; SHINERS: *Notropis photogenis* (Cope)
A specimen was collected in Green River.

EMERALD MINNOW: *Notropis atherinoides* Rafinesque
A large number of these little minnows were collected in Green River, and a series of specimens about the boat landing in Echo River in the lowest level of Mammoth Cave. Those from the cave show no characters to distinguish them from those in Green River.

WHIPPLE SHINER: *Notropis whipplii* (Girard)
Eighteen of these little minnows were collected in Green River.

SUCKER-MOUTH MINNOW: *Phenacobius mirabilis* (Girard)
A common minnow in the river, from which specimens were collected.

BLACK-HEADED MINNOW: *Hyborhynchus notatus* (Rafinesque)
Specimens were collected in Green River.

STONE ROLLER: *Campostoma anomalum* (Rafinesque)
Evidently a very common species in Green River, as 27 specimens were collected.

CATFISH: *Ictalurus punctatus* (Rafinesque)
Several species of catfish are common in Green River and are among the most prized food fishes, but specimens of only the one species were collected; other species cannot be given

with certainty. The fishermen distinguish them as blue cat, channel cat, silver cat, yellow cat, and other names of doubtful application.

BULLHEAD: *Ameiurus nebulosus* (Le Sueur)

The common bullheads, or hornpouts, are caught in Green River, where specimens were collected.

STONE CAT; LITTLE BULLHEAD: *Schilbeodes miurus* (Jordan)

A few of these little bullheads were collected in Green River.

KILLIFISH: *Fundulus notatus* (Rafinesque)

A few of these little top minnows were collected in Green River.

BROOK SILVERSIDES: *Labidesthes sicculus* Cope

A large number of specimens of these graceful little fishes were collected in Green River.

LARGE-MOUTHED BASS: *Micropterus salmoides* (Lacépède) [=*Huro floridana* (Le Sueur)]

These fine large fish are common in Green River where specimens of the young were collected.

KENTUCKY BLACK BASS: *Micropterus pseudoplites* Hubbs

From the description of the fishermen it would seem that there are several forms of bass in the Green River of which this is probably one.

SUNFISH: *Lepomis* ————?

Specimens of the sunfish collected in Green River were too young for specific determination. From the description of fishermen there would seem to be several species of sunfish and perch in Green River.

LOG PERCH: *Percina caprodes* (Rafinesque)

Several specimens of these little barred and banded perch were collected in Green River.

JOHNNY DARTER: *Boleosoma nigrum* (Rafinesque)

Considerable numbers of specimens of these little darters were taken in Green River.

SPOTTED SAND DARTER: *Crystallaria asprella* (Jordan)
Specimens were collected in Green River.

SPECKLED SAND DARTER: *Ammocrypta pellucida* (Baird)
Specimens were collected in Green River.

GREEN-SIDED DARTER: *Etheostoma* ————?
Only one specimen of this little darter was collected, not sufficiently mature for determination.

SHARP-NOSED DARTER: *Hadropterus phoxocephalus* (Nelson)
A large number of specimens of these little sharp-nosed fishes were collected in Green River.

RAINBOW DARTER: *Oligocephalus coeruleus* (Storer)
A brilliant male was collected in Green River by Giovannoli but the specimen was lost. The field identification, however, seems positive.

BLOB; MILLERS THUMB; SCULPIN: *Cottus bairdi* Girard
Six of these little short speckled fishes were collected in Green River and two in the Backwater of Mammoth Cave, an overflow pond filled from Echo River at high water. No peculiarities of color or markings were noted on those from the cave but they are known to inhabit caves, where they grow to unusually large size.

FRESH-WATER DRUM; SHEEPSHEAD: *Aplodinotus grunniens* Rafinesque
One of the valuable food fishes of Green River. Recognized by Giovannoli among the catch of the fishermen.

Photo by Willis T. Lee, Courtesy U. S. Geological Survey.

SUPPOSED EXIT OF ECHO RIVER

Fig. 85.—This cave exit is flooded by high water in Green River and is supposed to connect with the underground waters of Mammoth Cave. It opens under the base of the cliff well back from the river bank.

V.—REPTILES OF THE MAMMOTH CAVE REGION

VERNON BAILEY

TURTLES

SNAPPING TURTLE: *Chelydra serpentina* (Linnaeus)

Snapping turtles are said to be common in Green River near Mammoth Cave, and two small specimens were taken by Giovannoli, one in the gulch only a few yards above the entrance to Mammoth Cave, and the other from a small stream north of the river. Large individuals taken in the river are sometimes eaten and are excellent both for soup and the tender, nutritious meat. They are savage animals, very destructive, to wild life, especially to water birds and swimming mammals such as the muskrats. In most localities their destruction should be encouraged.

BOX TURTLE: *Terrapene carolina* (Linnaeus)

These little box turtles are fairly common in the woods about Mammoth Cave where Giovannoli collected several specimens and examined others. Two were found on the edge of a pond in the woods, one of them buried almost out of sight under leaves and mud at the water's edge. Others were examined and released near the entrance of Mammoth Cave. They are harmless and to some extent useful little animals, gentle and interesting as pets and well worthy of study and protection.

MAP TURTLE: *Graptemys geographica* (Le Sueur)

One specimen, taken by Giovannoli in Green River near Mammoth Cave, was shot while basking on a log. Funkhouser reports it as common along the Ohio River, where it is prized as an article of food. It attains a length of 10 to 12 inches.

CUMBERLAND TURTLE: *Pseudemys elegans* (Wied)

One specimen was taken by Giovannoli in Green River, just below the mouth of Mammoth Cave. Funkhouser says

"this brilliantly marked turtle is easily recognized by the broad crimson band extending from behind the eye to the base of the head. It is excellent as food, very hardy and long lived, eats almost anything and lives well in captivity."

STRIPED TURTLE: *Pseudemys concinna* (Le Conte)

Giovannoli secured one specimen from some fishermen on Green River. It had been caught in a fish net.

LIZARDS

BROWN SWIFT; FENCE LIZARD: *Sceloporus undulatus* (Latreille)

These little scaly lizards are abundant in the woods along fences, and over logs or rocks. Less often they are seen on the ground but usually running for the nearest tree or log. They are bright, pretty little lizards with keen eyes and quick motions. They feed on insects and small animal life, which they are skillful in capturing, are perfectly harmless, very useful, and interesting little animals.

WHIP-TAILED LIZARD; SIX-LINED LIZARD: *Cnemidophorus sexlineatus* (Linnaeus)

These very slender, long-tailed striped lizards are not so common or generally distributed as the fence lizards, but Giovannoli found them fairly common in Eaton Valley, about a mile northeast of Mammoth Cave. They were on the bare ground of eroded hillsides and in adjoining scrubby pine timber. They are ground dwellers and prefer the open places, where they bask in the sun or run with great speed to the cover of rocks, logs, or burrows. They feed on insects, which they are very skillful in catching, and are harmless and very useful animals.

BLUE-TAILED SKINK; SCORPION: *Eumeces fasciatus* (Linnaeus)

These smooth little lizards, blue-tailed when young and red-headed when old, are one of the very common species found in the woods or on any uncultivated land where there is cover and plenty of insect food. They are mainly ground dwellers, taking refuge under logs, bark, stones, or leaves, or

burrowing into mellow soil and catching their food on or near the ground. They are very useful animals and perfectly harmless although many people believe them to be extremely venomous and kill them on every occasion. The name scorpion is possibly in part responsible for this superstition, but there is no more excuse for this name than for the rest of the misinformation regarding them.

GLASS-SNAKE; JOINT-SNAKE; SLOW WORM; BLIND WORM: *Ophisaurus ventralis* (Linnaeus)

This unique reptile is neither snake nor worm, but a long, legless lizard adapted to a burrowing life and for this reason not often seen. No specimens were collected in the cave region but Kentucky is within its range and Funkhouser gives it as fairly common throughout the state. It can be distinguished from any snake by the fine scales of the belly instead of wide scales that reach clear across the belly in snakes; by the movable eyelids, and the brittle tail, which breaks off at the slightest pressure, giving its name of glass-snake and joint-snake. As in other lizards, a new and shorter tail grows when the original tail is lost, but contrary to common belief the broken-off piece dies and does not grow again. Like all lizards of this region, it is harmless, useful, and interesting and should be protected and studied rather than destroyed.

SNAKES

TIMBER RATTLESNAKE: *Crotalus horridus* Linnaeus

These black-tailed rattlesnakes are said to be common locally in the timbered parts of the cave region. Giovannoli examined three that had been killed in or close to the road, just east of Mammoth Cave, the largest measuring four feet and six inches in length.

COPPERHEAD: *Agkistrodon mokasen* Beauvois

One copperhead was collected by Giovannoli just back of the Mammoth Cave Hotel and others were reported. According to the local people they are fairly common, but with much tramping in the woods I was not able to find any.

GARTER SNAKE: *Thamnophis sirtalis sirtalis* (Linnaeus)

This was the only species of garter snake found in the Mammoth Cave region but it makes up in number of individuals for lack of other forms. It is by far the commonest snake of the region.

GRAY-BELLIED BROWN SNAKE: *Storeria dekayi* (Holbrook)

One specimen (No. 237)* of this little snake was collected by Giovannoli about a mile east of Mammoth Cave. Apparently it is a rare species here.

RED-BELLIED BROWN SNAKE: *Storeria occipito-maculata* (Storer)

One specimen was collected (No. 264)* in the road about a mile east of Mammoth Cave. It is a pretty little snake, clean, shiny, and very gentle, and makes a most attractive pet.

COMMON WATER SNAKE: *Natrix sipedon sipedon* (Linnaeus)

Found about ponds and along Green River. One was collected at a pond near the old entrance of Mammoth Cave and one as it swam across Green River. They are generally found in the water and are sometimes confused with the water moccasin. They are very pugnacious though harmless except for their sharp bite. They feed largely on fish and other water life.

RED-BELLIED WATER SNAKE: *Natrix sipedon erythrogaster* (Shaw)

No specimens were taken of this red-bellied form of the water snake but Funkhouser gives it as "common in all parts of the state." It is the southern form of water snake and Kentucky is evidently in the area of intergradation. In habits it apparently does not differ from *sipedon*, the northern form.

MILK SNAKE; CHECKERED SNAKE: *Lampropeltis triangulum triangulum* (Lacépède)

No specimens of these common snakes were secured, but among other large spotted snakes they may have been overlooked. Funkhouser gives them as "very common throughout

* Field number in Giovannoli's catalogue.

the state." The name must have come from the silly superstition that they suck the cows, and the name checkered snake from the checkerboard pattern on the belly would be better than milk snake for general use.

BLACK KING SNAKE: *Lampropeltis getulus nigra* (Yarrow)

One specimen of this dark form of the king snake was captured by Giovannoli close to the old entrance of Mammoth Cave. As usual it proved gentle and easily handled after capture and was shown to the many interested visitors. For snakes that feed largely on other snakes, including the venomous kinds, these beautiful smooth and shiny-coated king snakes are surprisingly gentle and harmless to man. They make most attractive pets and are easily and safely handled.

FOX SNAKE: *Elaphe vulpina* (Baird and Girard)

This large light brown and chocolate-blotched snake attains a length of six feet with a heavy body and short, pointed tail. Funkhouser reports it as common throughout Kentucky, but we did not secure a specimen from the Mammoth Cave region. Its name is said to be derived from its fox-like odor. It is considered a useful species in the destruction of mice and rats.

BLACK PILOT SNAKE: *Elaphe obsoleta obsoleta* (Say)

Funkhouser gives the black pilot snake as common in Kentucky, especially in the eastern mountains, and lists specimens from Edmonson County. In habits he says it is a harmless and useful species, somewhat resembling the black snake.

GRAY PILOT SNAKE: *Elaphe obsoleta confinis* (Baird and Girard)

A specimen collected by Giovannoli at Mammoth Cave was not recognized by any of the local people who saw it. Another at Mammoth Onyx Cave was found in the woodpile and killed by the boy who was chopping wood. It was about two feet long, blotched with chocolate brown spots along the back, and had a mottled belly.

BLACK SNAKE: *Coluber constrictor constrictor* (Linnaeus)

Black snakes are one of the commonest species about Mammoth Cave, as over the rest of Kentucky, outnumbered perhaps only by the garter snakes. They are often found about houses as well as in the woods. Their great length, slender graceful form, shiny black coat, and white throat afford easily recognizable characters. They are very swift, great tree climbers, and notorious robbers of birds' nests, but they also do much good work in the destruction of rats and mice.

ROUGH GREEN SNAKE: *Opheodrys aestivus* (Linnaeus)

No specimens of this pretty little slender green snake were obtained, but it is well known among the local residents, who believed it to be deadly poisonous and were afraid to bring in any for specimens. This belief is very general but entirely without foundation. Gentler and more harmless snakes could not be found and they can not be even induced to bite. They feed mainly on insects and are really very useful animals.

RING-NECKED SNAKE: *Diadophis punctatus edwardsii* (Merrem)

One specimen (No. 257)* was collected by Giovannoli in the back end of Mammoth Onyx Cave at a point near the surface where it had probably crawled in. The only previous record of this little black, yellow-bellied, and yellow-collared snake in Kentucky is given by Funkhouser from Frankfort. It is a harmless little snake, hiding away under logs and stones and feeding on earthworms and ants. In turn this specimen, after being killed and thrown aside by some thoughtless person, was being eaten by cave crickets.

WORM SNAKE: *Carphophis amoena helenae* (Kennicott)

Several specimens of these tiny, brown, salmon-bellied worm snakes were dug out of the earth and leaf mold a few inches below the surface where a new road was being built through the woods just above the old entrance of Mammoth Cave. They are burrowing snakes, getting their food of small insects and larvae in mellow soil or on the surface of the

* Field catalogue number.

ground, under logs, bark, and stones. They are perfectly harmless and quiet little animals that would be more interesting if we knew more about them.

HOG-NOSED SNAKE; BLOW SNAKE; SPREADING ADDER: *Heterodon contortrix* (Linnaeus)

Two blow snakes were captured near Mammoth Cave and one near Mammoth Onyx Cave and they are reported as common in all parts of Kentucky. They are short, stout little snakes, a foot or two in length, and their habit of flattening and spreading the head and neck as they blow and hiss is familiar to all who live in the country. They are greatly feared and generally supposed to be venomous, but their performance is only a bluff. They are perfectly harmless and very timid. They feed extensively on toads and in this way destroy animals more useful than themselves, but the toads are so exceedingly prolific that there are usually enough left.

VI.—AMPHIBIANS OF THE CAVES AND CAVE REGION

VERNON BAILEY

FROGS

BULLFROG: *Rana catesbeiana* Shaw

These big dark green bellowing frogs are found in abundance in the ponds and pools which abound in the cave region and occasionally out in the woods or open country at considerable distance from water. The small or medium-sized frogs are most abundant as few are allowed to live to great age and size. Occasionally very large individuals are taken but they are not so tender and delicate as the medium-sized frogs. To the epicure frogs' legs rolled in corn meal or flour and fried to a golden brown in bacon grease or butter are one of the greatest delicacies of the table, and if this fact were more generally appreciated the numerous ponds of this region would greatly increase in value.

Bullfrogs feed upon small minnows, grasshoppers, and other insects, and a great variety of small animal life. They breed in May or June and the young remain as tadpoles until the second or third year before becoming real frogs. The heavy bellowing of these frogs in spring and early summer is one of the thrilling sounds of nature.

GREEN FROG: *Rana clamitans* Latreille

These medium-sized, speckled green frogs are common about ponds and along streams, usually in or near the water where a long leap takes them to safety. They are mainly solitary and very timid. They feed upon insects and larvae, small crustaceans, small frogs, and other aquatic life. They are good eating but not large enough to have any important food value.

PICKEREL FROG: *Rana palustris* Le Conte

These medium-sized brown frogs, with two rows of dark brown spots, are common in the ponds and streams and are

generally found in the caves, not far back from the entrance. I collected one in Mammoth Onyx Cave and Giovannoli found them in many other caves. He found a small and very emaciated individual on the banks of Echo River in the lowest level of Mammoth Cave. More than any other frog they are regular inhabitants of the caves. One had a cave cricket in its mouth when taken.

LEOPARD FROG: *Rana pipiens* Schreber

Leopard frogs were not collected in the Mammoth Cave region but may well be there as they are one of the commonest frogs over the eastern United States. They are medium-sized, slender green frogs with black spots in irregular rows, often found far from water, in marshes, meadows, and fields, feeding upon insects, larvae, worms, and other small animal life. They are very gentle, easily captured and handled, and excellent for keeping in captivity for laboratory studies. They are good eating and are often used for food when larger species cannot be obtained.

CRICKET FROG: *Acris gryllus* (Le Conte)

The little brown cricket frogs were numerous in weedy woods and around ponds at Mammoth Cave, where on early summer evenings their cricket-like chorus was almost continuous. With the very small discs on the end of the toes they are not good climbers and live mainly in the weeds or marshes or weedy ponds, taking refuge in the water when alarmed. They feed upon insects and are useful as well as interesting little musicians.

Two other small species, a swamp tree frog (*Pseudacris triseriata*) and the spring peeper (*Hyla crucifer*) of widespread distribution in the eastern states, are surely present in the region, but were not detected.

TREE FROG; TREE TOAD: *Hyla versicolor versicolor* (Le Conte)

These little gray, green, or brown, rough-coated, sucker-toed tree frogs are abundant around Mammoth Cave grounds but were not found actually within the caves. Giovannoli reported their incessant call notes up to early August, so loud and continuous as to fairly make one's ears ache. With the

large suction discs on the tips of their toes, these pretty little frogs are great climbers and live mainly on trees, bushes, or walls, where they catch their insect food and sing vociferously. In May they lay their eggs on grass or plant stems in the water, sometimes in temporary pools. They usually hibernate in the hollows of trees.

COMMON TOAD: *Bufo americanus americanus* Holbrook

These big warty toads are common throughout the cave region but not so numerous as Fowler's toad. They are most often seen at evening, hopping slowly along the trails or walks or over the lawns, and every morning irregular lines of their unmistakable tracks are seen in the dust or sand of the roads and trails, or on smooth cultivated land. They feed mainly on insects and insect larvae on or near the ground and take many of the most harmful species. They are hearty feeders and are of great value to the farmer and to all of us, meriting our full protection and interest. While they are exceedingly plain in appearance, their eyes are brilliant and beautiful in color and expression, which may account for the legend of the ugly toad with a rare jewel in its head.

FOWLER'S TOAD; LITTLE TOAD: *Bufo fowleri* Hinckley

These smaller, smoother, drab gray or greenish gray toads are far more numerous than the big warty common toads and are generally distributed over this region. Around small ponds in April they were so numerous that the ruts in the road were full of those killed by automobiles, and on warm evenings they were seen hopping away on all sides as we walked along the roads. During summer they were often seen, hopping over the lawns at Mammoth Cave Hotel and even coming up the steps onto the porches. Later, in the dryer part of summer they were less conspicuous although along the shores of Green River they could be seen at any time during the summer. Their abundance makes them probably the most useful of all the toads of this region, but we need to know a great deal more about the food and general habits of these humble friends of man.

SALAMANDERS

According to Doctor Eigenmann (p. 10), there are no entirely blind salamanders among the cave-dwelling species in this country, although two species, *Typhlotriton spelaeus* Stejneger from caves in southern Missouri and *Typhlomolge rathbuni* Stejneger from caves in Texas, have quite degenerate eyes. Two other species of cave-dwelling salamanders, *Spelerpes maculicauda* (Cope) (or *Eurycea lucifuga* Rafinesque) from Indiana and Kentucky and *Spelerpes stejnegeri* Eigenmann [=*Eurycea melanopleura* (Cope)] from southern Missouri, have quite normal eyes, as have the several other species often found in caves. While many salamanders enter caves to a limited extent, few are restricted to them.

SPOTTED SALAMANDER: *Ambystoma maculatum* (Shaw)

The spotted salamander was not collected in the Mammoth Cave region but should be a common species there. It is a heavy, wide, slow-moving species, marked with round yellow spots over the blackish back. Other forms of the genus may occur there also.

BROWN SALAMANDER: *Desmognathus fuscus fuscus* (Rafinesque)

These small brown, speckled-bellied salamanders were abundant in the small streams running out of Three Springs, two miles northeast of Mammoth Cave. They were found both in and out of the water, but were very active and not easily captured. They were not found in the caves.

MOTTLED SALAMANDER: *Plethodon dorsalis* (Cope)

One of these little salamanders was collected in Mammoth Onyx Cave, half-way back to the end in a moist niche in the rocks, where its little black head glistened in the light of my flash. Its colors were dark and normal, but in this not very extensive cave they are not far from the effects of light and are within easy reach of the surface.

SLIMY SALAMANDER: *Plethodon glutinosus* (Green)

Giovannoli found this salamander in the mouth of Dixon

Cave among damp leaves on a pile of rotten logs, and another near the Dead Sea, deep down in Mammoth Cave. They were very active and difficult to catch.

RED SALAMANDER: *Pseudotriton ruber ruber* (Sonnini)

The red salamanders are found rather abundantly in the creek coming from Three Springs, about two miles northeast of Mammoth Cave. They were living in the cold spring water, under stones and pieces of wood, and were easily recognized by their bright vermilion color and numerous black spots. They were not found in the caves.

CAVE SALAMANDER: *Eurycea longicauda* (Green)

One specimen of this long, slender, orange-yellow salamander, with numerous black specks, was found on the damp earth near Echo River in the deepest part of Mammoth Cave, within a hundred feet of the boat landing where visitors are given their boat ride on the river. It is a cave-dwelling species of wide distribution, but has not lost its eyesight and is capable of living both outside and inside of caves.

VERMILION SPOTTED SALAMANDER: *Eurycea lucifuga* Rafinesque; *Spelerpes maculicauda* (Cope)

These bright red salamanders with dark brown spots were found in several of the caves in moist ground near water, both in the dim light and in total darkness. One was taken near the Dead Sea in the lower levels of Mammoth Cave. They are one of the commonest cave-dwelling species and probably occur in most of the caves of this region. Although true cave dwellers, they have apparently normal eyes and are brightly colored.

GREEN NEWT; RED EFT: *Triturus viridescens viridescens* (Rafinesque)

These little greenish or reddish salamanders with yellow bellies and scarlet dots over the sides were found under slabs of bark on the ground near Green River, near the pond at Mammoth Cave, and near a spring in Eaton Valley. The specimens collected were all in the immature red stage, indicating

an abundance of the greenish adults in the ponds and sluggish streams near by.

MUDPUPPY; WATERDOG: *Necturus maculosus maculosus* (Rafinesque)

These big bushy-gilled, brown and spotted waterdogs sometimes attain a length of a foot or more and are wholly aquatic. While generally more northern in range, they are evidently common in Green River at the mouth of Mammoth Cave, as the fishermen all know and describe them perfectly. They are often caught on trot lines in the spring and might easily enter the lower levels of the caves through underground waterways connecting with the river. They are generally considered poisonous, dangerous, and mysterious, but really are perfectly harmless, very interesting, and even edible, representing one of the lower groups of amphibians most of which have not yet emerged from the strictly aquatic stage.

VII.—INVERTEBRATE LIFE OF MAMMOTH AND OTHER NEIGHBORING CAVES

LEONARD GIOVANNOLI

To the average tourist Mammoth Cave must seem almost wholly without an invertebrate population. Perhaps a midge may be seen about Echo River, or some sharp-eyed person may discover a cave cricket, or the guide may point out a white crayfish in the shallow water. Very few people see more than this and no one visiting the cave in the usual manner can obtain a true conception of the surprisingly varied invertebrate fauna. No less than forty-one species have been found to be more or less permanent dwellers in the Kentucky caves. Many others visit the caves commonly and still others stray in occasionally.

Strays and chance visitors to the cave might include almost any form found outside near the entrance. It is impossible to include here all of these, so this account has been limited to the discussion of the regular cave inhabitants with a few of the more common visitors.

Animal life is not evenly distributed throughout the caves. Large areas seem wholly without life while close examination in other parts shows small areas to be teeming with life. Moisture seems to be the most important factor affecting the distribution of invertebrates, since none were found where the ground was very dry, while wherever it was damp some forms existed. Even in the moist regions the population was not evenly distributed but was found concentrated as might be expected about the spots where food was present.

Wood seems to be the chief source of food. Other organic materials washed in by the streams, guano from the bats and rats, and now and then a dead animal also furnish some nourishment, but probably the majority of species are dependent, directly or indirectly, on decaying wood and other vegetation. Molds grow luxuriantly on the wood, and no doubt some crea-

tures live on these while others probably use the wood itself. Spiders or other predacious forms, living on their milder mannered neighbors, are found in each woodpile community. Less particular creatures, the scavengers, eating almost anything, are abundant.

It is not difficult to understand why animals live in caves when they might be living outside where there is light and more abundant food. Competition is keen outside and those animals that are fitted to thrive under unusual conditions find some relief in retreating into regions unpleasant for or perhaps inaccessible to their enemies and competitors. In this way every place at all suitable for the existence of life has been colonized by some form. While some active creatures roam boldly in the open, others creep about in sheltered places; some live under logs and stones, or in holes in the earth made by other animals; others make their own burrows. Even in these retreats there is still the pressure of competition encouraging those that can take advantage of any unfilled niche. In this way probably the caves were colonized shortly after they became habitable, scavengers and such arriving first, with the predacious species close behind them.

Reduction of eyes, wings, and color, and the development of other organs fitting them for their subterranean existence probably commenced before the cave-inhabiting period began. It is possible to find all gradations between the blind, white, cavernicolous forms and the functional-eyed, brightly colored, light-loving types, living today in the intermediate conditions.

To an animal more or less adapted to life in total darkness, cave conditions may be anything but unpleasant. Except for the meagerness of the food supply other factors are rather favorable. There are no high winds, no rains, no droughts, no extremes of temperature. While food is at no time abundant, there is no periodic season of starvation. Such uniformity relieves the organism from the necessity of devising means of surviving the extreme and sometimes violent changes common on the earth's surface. These conditions have proved attractive enough to induce representatives of most of the major groups of animals to choose the caverns for their homes.

SPIDERS AND THEIR RELATIVES, ARACHNIDA

SPIDERS: ARANEIDA

Spiders are found in caves from the entrance to the remotest chambers. Those near the entrance show little or no adaptation to life in darkness, while those living far in show the reduction in eyes, color, and size common to most truly cavernicolous animals.

A large spider, *Meta menardii* (Latreille) is to be found in the middle of its orb web from the entrance to well beyond the last trace of light visible to the human eye, but never in the depths of the caves. It is an outdoor form that prefers cool shady places, such as recesses in shaded cliffs, under culverts, and the mouths of caves.

The female when full grown measures one-half an inch or more in length, and has a large abdomen high in front. It is dark brown with translucent and yellowish markings.

Many specimens of this species were taken at the inner end of Dixon Cave and in White's Cave, always from empty webs in perfect condition, indicating that meals were few and far between. The large translucent white egg-sacs were seen not far in from the entrance of Buzzard Cave, hanging near the web from the ceiling. While not collected in Mammoth Cave it doubtless occurs in the entrance.

MITES: ACARINA

Mites have long been known to inhabit these caves but as yet they have been given relatively little attention. Careful searching with a strong light is necessary to discover these small relatives of the spiders and ticks. They rarely exceed one millimeter in length, and many of them are so colored that they are not conspicuous against a background of mold-covered wood on which they are most often found. On several occasions specimens have been collected and given names, sometimes without accompanying adequate descriptions. This has led to some confusion, making it difficult if not impossible to be sure just what mite it is that one collects.

Nathan Banks described two species collected by R. Ellsworth Call about 1896. These were supposed to be new species not previously named.

One of these, *Rhagidia cavicola* Banks, is a very small mite, about .7 mm. in length. It is blind, entirely without eyes, with a whitish body and hyaline legs. It is less globular than most mites and has relatively long legs. This mite is somewhat common, according to Call, under stones in damp situations, especially may it be found under stones to which the egg masses of the small cave spider, *Anthrobia mammouthia*, are attached. It is not known to attack these egg masses but the association is suggestive.

Another mite, *Linopodes mammouthia* Banks, is said by Call to be the smallest form discovered in the cave. It is but .5 mm. in length, pale yellowish, with even paler legs. Its body is rounded oblong with three pairs of normally short legs and one pair, the first, nearly four times the length of the body. This species has two shining eyes but of what use they are in the darkness of the cave must be imagined. It probably depends more on its long front legs, which are kept in constant motion, and the bristles or hairs on its body, for information about its surroundings. It occurs on the under side of stones and sticks and on the earth under them.

Packard lists five species from Mammoth Cave region but failed to describe them adequately, depending probably on his figures to serve as descriptions.

Rhyncholophus cavernarum Packard is a small white species, .8 mm. in length, that he found in White's Cave. It has also been collected in Long Cave.

Laelops (= *Iphis* ?) *cavernicola* Packard is an oval, pale horn-colored mite, 1 mm. in length, found in Mammoth Cave under the mold covering rotting sticks.

Gamasus troglodytes Packard is said to occur with the preceding in Mammoth Cave.

Damaeus (=*Delba*) *bulbipedata* Packard is an egg-shaped mite with long legs of which the joints are all more or less bulbous. This mite came from Dixon Cave.

Oribata alata Packard, another from Dixon Cave, is peculiar in having its short round body extended out all around, forming a sort of carapace under which the legs can be hidden from above.

In addition to fleas, the little brown bats have other kinds of parasites to annoy them. Two species of almost microscopic sucking "lice" were abundant on these small bats. One of these bat mites, *Ichoronyssus* sp., was found on the little sooty bat, *Myotis sodalis*. The other species, *Liponyssus* sp., was taken from the little sooty and two species of little brown bats, *Myotis sodalis*, *Myotis lucifugus*, and *Pipistrellus subflavus*. These bats from which the mites were taken, were all collected in Colossal Cavern in November, 1929, after they had begun their winter sleep. An attempt was made to keep them in hibernation through the winter, but they died during the following February and March. The mites remained active throughout the winter and seemed to increase in abundance. It is probable that they contributed to the emaciation and were partly responsible for the death of the little bats.

PSEUDOSCORPIONS: PSEUDOSCORPIONIDA

Another peculiar relative of the spiders, one of the pseudoscorpions, *Chthonius packardii* Hagan, is always to be found in the caves. It is not restricted to underground existence, however, but has been collected outside also. It shows a very remarkable trait in being able to produce eyes when it develops in the light while those developing in the caves have no eyes. Its whitish body and appendages are long and more slender than is usual for pseudoscorpions. Its maximum length is about three and a third millimeters but most of those seen are much smaller than that. It is found under stones and fungus and on decaying wood.

Some larger pseudoscorpions (*Chelanops* sp.) were found in White's Cave living in accumulations of dry rat dung. They were in total darkness but were not very far from the entrance. It is probable that they are not regular inhabitants of the caves.

HARVESTMEN: PHALANGIDA

One species of harvestman, or grand-daddy-long-legs, *Phalangodes armata* Tellkampf, has long been known as a resident of Mammoth Cave and other caves near by. It has lost its coloring and its eyes. There is no longer even a nerve running to the spot that marks the location of the eye, such

as must have been possessed by its ancestors. Its body is about 3 millimeters long, with legs 12 to 15 millimeters in length. This is a very delicate creature, its slow movements not in the least suggesting predatory habits. However, if its appendages, used by harvestmen to find and seize their prey, are examined, they will be found very suggestive of a bloodthirsty appetite. It probably feeds on mites and small soft-bodied insects found on the decaying lumber about which it usually lives.

MILLIPEDES: MYRIAPODA

Both millepedes and centipedes have been found in Mammoth Cave but only one small species of the former, *Scoterpes copei* Packard, seems to be restricted to such a life. Similar millepedes are found in most of the large caves of other parts of the country, but this species seems to be peculiar to the Mammoth Cave region. It reaches a length of about eleven millimeters, has twenty-four segments, fifty-two pairs of legs, and is covered with hair. It is white and has no eyes. These myriapods are found in damp situations from near the entrance to the innermost ends, practically everywhere there is the least bit of organic matter. They are most abundant about the piles of rotting wood, sometimes under the wood, sometimes creeping slowly along out in the open. They exist pleasantly enough probably since millepedes in general are satisfied to live in damp, dark places feeding on decaying vegetable matter.

Another small millepede identified as probably *Cambala annulata* Say was collected in White's Cave. This species is hardly so white as the above, and has a straight row of six small ocelli, or eyes, on each side of its head. It lacks the hairs of *Scoterpes*, has fifty-nine segments, and grows to a much greater length, although those caught in the cave were small. It has been reported from many caves in other states more often than in Kentucky, but it does not seem to be confined to caves as is the preceding species.

Near the Dead Sea several specimens of a stout, active centipede, as yet unidentified, were found under a rotting plank. These were brownish, about one-half an inch long, and showed no evident adaptation to life in caves. It is prob-

able that they were visitors, or perhaps they were brought in on lumber.

INSECTS

CAVE CRICKETS: ORTHOPTERA

One of the most familiar forms of cave life is the "cave cricket," which is not a cricket at all but is a peculiar type of "long-horned" grasshopper. They are wingless, with very long legs, and antennae three to four times the length of the body. The body is rarely more than four-fifths of an inch in length, pale yellowish brown with fuscous blotches on the back. This species, *Hadenoecus subterraneous* Scudder, is found only in caves, and is most abundant in total darkness, but can be taken in numbers also near the entrance where there is considerable light. It is not confined to Mammoth Cave but is common in many other caves near by and in Tennessee, but so far has not been found in the Indiana caves. It is the only cave cricket to be found in Mammoth Cave, where it inhabits all the moist parts. It is usually found in groups clinging to the walls or ceiling, apparently always resting, but once in a while one will be observed walking along slowly feeling ahead with its long antennae. They are capable of making long leaps but seem to do so only to escape danger.

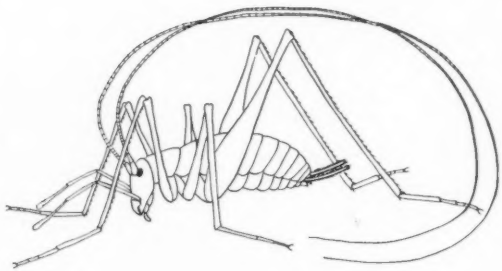


Fig. 86. The so-called Cave Cricket, *Hadenoecus subterraneus*, really a cave grasshopper or katydid, found in most of the caves.

They seem somewhat sensitive to light and to noise. Scudder says they can see. Certainly they have eyes, which, though small, are black and apparently well developed. Their actions indicate increased alertness when a light is thrown on them

and much of a disturbance will start them to jumping and crawling away, but they are very easily caught and with care can be picked up with the fingers. What vision they have must be very poor.

These crickets are evidently scavengers, but what naturally constitutes their main food supply is not definitely known. When traps were set in the caves for mice and rats they proved a great nuisance by eating the baits and also nibbling at the rats that were caught. They seemed to relish rolled oats, peanuts and peanut butter, nuts, raisins, and fresh meat of any kind. They seem to smell well for they located a meat bait a few minutes after it was laid out. The only things offered that they refused were bacon rind and green clover. The latter left near a meat bait was untouched although the meat was soon devoured. In one electrically lighted cave green moss has made considerable growth near some of the lights, but although crickets were abundant near by none were ever observed on the moss.

At any time during the summer crickets of almost any size could be found, indicating either a very slow growth or irregular breeding. Only once was any indication of breeding observed and that was on August 15 when a pair were seen mating. Like all insects at some stage, these shed their skins. One, surprised molting, was milk white when just out, but in a few hours was practically as dark as usual.

Another so-called cave cricket, *Ceuthophilus stygius* Scudder, has been reported from Mammoth Cave but has not been taken there recently. Two were collected in 1929, one near the entrance but outside, another some distance away from any cave in a neighboring woods under a log. These crickets are common in caves in Indiana but usually near the entrance. They are larger, stouter, and darker colored than the preceding species and are probably not so strictly subterranean in habits.

FLIES: DIPTERA

"It is said that there are no true cave flies. By this it is meant that no flies are known to have become so exclusively cave inhabitants that eyes, pigmentation, wings, etc. have become reduced as in the beetles. Those that do breed normally in

caves are usually found also in houses, cellars, and out of doors, several being circumpolar or cosmopolitan in distribution. Even the drone of a bluebottle fly, lost in the dark but still following some taint, indistinguishable to human senses, from a dead bat or discarded lúnch, can sometimes be heard, but a number of less conspicuous scavenger species are abundant in all caves, and they and their larvae probably supply the predators, beetles, spiders, etc., with most of their sustenance," Barber.

A dozen or more species of flies and fly larvae have been taken from the caves, some of them merely strays seeking cool, moist places, but others were breeding and probably had been in the caves for generations.

Packard lists six species as temporary residents in the caves and one, *Blepharoptera defessa* (now *Amoebaleria defessa* Osten Sacken), as a permanent resident. At least three of these six should be classed with the last, since *Megaselia*, *Sciara*, and *Chironomus* are always in the cave, breeding far from the entrance. Call added to the list of probable permanent residents another small fly, *Limosina stygia* Coquillet. It is safe to say that there are five species of flies that repeatedly complete their life history in Mammoth Cave without seeing the light of the sun.

One of the most conspicuous of these is an unidentified species of midge, *Chironomus*, that is always present in small numbers in River Hall. These delicate flies spend most of their time on the mud banks of Echo River and are often scared up and seen by the visitors as they embark for their subterranean boat ride. Very little is known about this midge. Its larvae have not been found but it is probable that they live in the water or mud of Echo River.

The fungus gnat, *Sciara* (*inconstans* Fitch?), a brownish black little fly about 3 mm. long, with grayish iridescent wings, has been collected by almost every investigator in the caves. It is known as a fungus gnat because its larvae live in decaying fungi. They have been found in other decaying vegetable matter also. Call found the larvae in a decaying apple near Richardson's Spring, and states that the adults are quite abundant in the damper portions of the cave. In 1929 both larvae and adults were taken about the Dead Sea.

Parties making the trip over Route Four in Mammoth Cave have lunch at a point about three miles in from the entrance. Here the accumulations of left-overs from the generous lunches put up by the hotel furnish food for hundreds of larvae of a small black hump-backed fly, *Megaselia cavernicola* Brues, probably the *Phora rufipes* Meigan of the older writers. Larvae, pupae, and adults were found here in large numbers particularly about the scraps of fried chicken. The larvae were rather active and could be seen crawling about over the earth and rocks apparently in search of food. The pupae lay exposed on the earth or rock or in debris near the food. The adult, 2 to 3 mm. long, flew freely about the table rock and the refuse but not in as large numbers as might be expected from the numbers of immature forms. This species was also collected about the Dead Sea. Call found it at the Mammoth Dome and in the Labyrinth about the masses of *Rhizomorpha*, a fungus common on the decaying timbers.

Call collected another small black fly, *Limosina stygia* Coquillet, about a fungus, *Coprinus*, growing on the mud brought in to River Hall by flood water. The larvae were found in the decaying fungi while the adults were noted walking on the damp earth, seldom flying except when disturbed and then only for a short distance.

Several specimens of a fly 5 to 6 mm. long were taken in Buzzard Cave and White's Cave. All were found at rest on the ceiling or walls, apparently almost dormant. This species, *Amoebaleria defessa* Osten Sacken, is said to pass the larval stage in the excrement of bats.

One species, parasitic as larvae, found several times in Dixon and Mammoth Caves, can hardly be classed even as a stray in the caves since it is carried in by its hosts, the cave rats. Many of these rats, *Neotoma*, were found with from one to five large larvae of the warble or bot fly, *Cuterebra* sp., in the subcutaneous tissue of the lower side of the neck and chest. Since bot flies as a rule do not bother animals in shady places, the presence of these larvae suggests that the rats come out of the caves occasionally during the bright hours of the day.

A few specimens of several other species of flies were found in the caves. Representatives of two species, *Oecothea*

fenestralis Fall and *Heleomyza brachypterna* Lw., that are found in European caves, were collected in Mammoth Cave. Far back in Great Onyx Cave one specimen of a small fly, *Leptocera* sp., was found under a rock. *Anthomyia* sp. has been reported from the caves, and in 1929 one pupa of the family Anthomyiidae, possibly *Anthomyia*, was found in rat dung in White's Cave. Larvae of *Mycetophila* sp. were found on a silken track on some dirty onyx wall in White's Cave. These slender larvae would travel back and forth on their track with considerable speed but could not be induced to leave it. Packard includes *Borborus* sp. in his list of temporary cave inhabitants. This fly was found breeding in dung and sometimes decaying fungi in Dixon Cave and Mammoth Cave.

BEETLES: COLEOPTERA

Next to the cave crickets, the most conspicuous insects in the caves are probably the beetles. Several species representing two families are abundant, the commoner forms are four species of predacious (Carabidae), the other being a carrion beetle (Silphidae). Other types are occasionally found in the caves and some are known to breed there, but they are probably not peculiar to the caves as are those mentioned above.

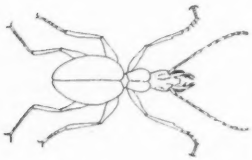


Fig. 87.—The Brown Predacious Beetle, *Anophthalmus*, are blind, about a quarter of an inch long and light brown. They are very active and found in most of the caves.

The predacious group, formerly known as *Anophthalmus*, are active beetles, frequently noticed running briskly over the damp ground but often found under stones also. They have a slender but typically ground-beetle form, with long legs and antennae. The membranous wings are absent, having long ago been lost through disuse, but the elytra or wing-covers are as usual except that they have grown together. The eyes, optic nerves, and optic lobes of the brain have entirely disappeared, but to compensate for this loss, the antennae are unusually well developed and on the head and body are numerous

setae or stiff hairs that have a sensory function. The color is brownish but the pigmentation is not heavy and the body has a translucent appearance. They vary in size but average less than one-fourth of an inch in length. The white larvae are a little longer, with unusually soft bodies for young Carabids. Like the adults, they have no trace of eyes. They are found under wood or stones on mud, sometimes forming little cells or pits about three-quarters of an inch long. Pupae may be found occasionally in such places.

These beetles belong to a family that is predacious, and they are assumed to be so themselves, since their activity and their structure indicate such habits, but little is actually known about their food. They are supposed to feed on small spiders, mites, harvestmen, and also probably on their own larvae and those of the carrion beetles but chiefly on flies and their larvae which come to decaying matter. Blindness and predaciousness are not often associated, but in the blind, dark world of the caverns this is not so anomalous as it might seem. In these beetles other senses are so well developed that they act very much as do beetles having the power of sight. They move quickly and without hesitation and are sensitive to light. From observation of their habits it is difficult to be sure that they are blind.

Four species of this type, representing two genera, are found in Mammoth Cave. These were all referred formerly to the genus *Anophthalmus*, an Old World group, but they are now considered as distinct genera. *Neaphaenops tellkampfi* Erickson is the largest species and one of the most common. *Pseudanophthalmus menetriesi* Motschulsky is smaller and usually lighter in color. It is fairly abundant also. *Pseudanophthalmus striatus* Motschulsky (=*interstitialis* Hubbard) and *Pseudanophthalmus audax* Horn are rather rare.

The carrion beetles (*Adelops hirtus* Tellkampf) are more numerous but less conspicuous than the preceding. These are less than one-eighth of an inch long, oval in outline, with short legs. They move quite briskly but since they are dark brown and so small they usually escape notice. It is difficult to get a correct idea of their abundance unless baits are laid out for

them. Fresh meat left in damp parts of the caves soon attract large numbers of both species.

The larvae and pupae are much more difficult to find. They probably feed on the same food as the adults. The larvae of

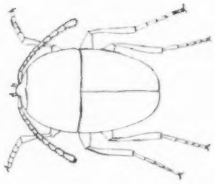


Fig. 88.—Scavenger Beetle, *Adelops hirtus*, a tiny, dark brown beetle, less than an eighth of an inch long.

Adelops hirtus are blind, dull white on the body, with a darker head. They attain a length of about four and one-half millimeters. The pupae are short and thick, a transparent white in color.

Like the predacious forms, these little beetles are so well adapted to living in total darkness that their actions can hardly be said to indicate blindness.

Rove beetles and their larvae are often found in the caves but are not considered to be strictly cave inhabitants. These are members of the family Staphylinidae, most of which feed on decaying animal and vegetable matter. Larvae, *Atheta* sp., were found twice, once near the Dead Sea and once near Mammoth Dome, both times in or under rotting wood. One adult, probably *Atheta*, was caught on a bat carcass left as bait at the inner end of Dixon Cave. This was a small beetle about two millimeters in length with the short elytra and long flexible abdomen characteristic of this family. It was almost black and probably had functional eyes.

Another small beetle belonging to a family, Pselaphidae, much like the last, was found at a rabbit carcass left at the inner end of White's Cave. Members of this family usually live under stones or bark, flying only in the twilight. The species might easily wander in to the cave but it probably does not make its home there.

MOTHS: LEPIDOPTERA

No adult moths or butterflies have been reported from Mammoth Cave, but larvae of a member, *Amydria* sp., of the clothes-moth family, Tineidae, have been found living in accumulated dung of the cave rat, *Neotoma*, in White's Cave. Certain piles of this dung not far from the entrance but in total darkness contained a great many of the long silk-lined galleries made by these larvae. But few larvae could be found and no pupae although there were numerous empty pupae cases in the dung piles.

FLEAS: SIPHONOPTERA

While fleas may not be classed as cave animals they are a constant feature of the fauna of caves used by bats. rats, and other mammals. Four species, *Phalacropsylla* sp., *Ceratopsyllus* sp., *Myoxopsylla sexdentatus pennsylvanicus* Jordan, and *Myodopsylla insignis* Rothschild, were taken from cave rats, *Neotoma*. The last named species was taken several times on little brown bats, which are probably its usual host. One of these little brown fleas was taken from a little brown bat, *Myotis lucifugus*, collected in Colossal Cavern, November 17, 1929. The flea was taken from the bat when it died in March, 1930, after hibernating up to that time, but the flea apparently did not hibernate.

Another species of flea, *Nycteridopsylla chapini* Jordan. was taken from a little brown bat, *Myotis sodalis*, from Colossal Cavern, collected November 17, 1929. These specimens of this recently discovered flea had apparently remained active all winter during the period of hibernation while the bats were torpid.

BOOK LICE: CORRODENTIA

Book lice and their relatives of the family Psocidae have at various times been collected in Mammoth Cave. Packard with expressions of uncertainty lists two species, *Atropos divinatoria* Muell (now *Troctes divinatorius*), the common book louse, and *Hyperetes tessulatus* Hagan. These were found with offal or the manure of bats.

R. Ellsworth Call collected some of these little, soft-bodied insects under fragments of wet and decaying boards in a small pit under the way leading to Gorin's Dome in Mammoth Cave. He supposed that these creatures found abundant food in the microscopic fungi growing there. This psocid was described by Banks as 1.5 mm. long, wholly pale except for reddish brown eyes and mandibles, with the wings rudimentary, and was named *Dorypteryx hagani.*

SPRINGTAILS: COLLEMBOLA

Springtails were abundant in many parts of the caves. Four or five species have been found. It is not surprising to find these insects in the caves, since many of their relatives living above ground prefer dark, damp places such as occur deep among dead leaves in the woods.

These are primitively wingless insects. Near the end of the abdomen underneath they bear a peculiar forked appendage controlled by strong muscles. This fork is kept folded forward, hooked to a small catch, and there held under more or less tension. If the insect is startled the hook releases the fork, which swings down and backward with such force that its owner is catapulted suddenly for some distance. This gives them their name of springtail.

Entomobrya cavicola Banks is a slender whitish hyaline insect about two millimeters in body length with short appendages. Their intestine, dark with food, may be seen through the body wall. This is the most common springtail in Mammoth Cave, being found on the damp earth almost anywhere, but in largest numbers on the piles of rotting, mold-covered lumber. Like some other cave insects, they have the habit of seeking safety under such things as stones and boards as do their near relatives outside. It would seem unnecessary to hide in this manner in the complete darkness of the caves. Call considers this habit to be "a strong argument in direct proof of the outside origin of the fauna as a whole."

If a piece of old lumber be picked up and examined closely, this species will generally be noticed creeping briskly about, but if an attempt is made to pick them up they apparently disappear, so sudden is their departure out of the spot of the

searcher's flashlight. They seem so well aware of approaching forceps or fingers that it leads one to believe that they are not blind, but there can be no doubt of this since they have no eyes.

Smynthurus mammouthia Banks, small mite-like springtails only 1 mm. in length, are found abundant in situations similar to those frequented by the above and often associated with it. Like the above, this insect is white or hyaline in color, but it is more globose in form with relatively longer legs and distinct eyes. It crawls quite slowly but is as difficult to seize as its more active associate.

Another species of springtail, *Tomocerus pallidus* Packard, was found near the Dead Sea and at the Mammoth Dome on damp earth and on and under pieces of rotting planks. This species is evidently what Packard called *Tomocerus plumbeus* Templeton, variety *pallidus*, in his memoir on cave fauna.

A few springtails, *Folsomia fimetaria* (L., Tull.) were collected in 1929 at Violet City, far back in Mammoth Cave. This seems to be the first time that this species has been reported from Mammoth Cave. It is possible that it has been recorded by some of the early collectors but under a different name.

Packard has described another, *Lepidocyrtus atropurpureus*, also from Diamond Cave. This springtail has eyes. Its dark purple body is only about 1 mm. long. Specimens identified as *Lepidocyrtus* sp. were collected at Violet City in Mammoth Cave and in White's Cave in 1929. These are possibly the same species that Packard found in Diamond Cave.

BRISTLETAILS: THYSANURA

Two members of the order Thysanura have been found in Mammoth Cave. These are primitive wingless insects, sometimes called bristletails on account of their long caudal filaments. Their bodies are flattened, narrow, and long, the antennae are long, the legs moderately so.

The most common one of these, *Campodea cookei* Packard, is very slender, white, and blind, its body about one-fourth of an inch long, with but two caudal filaments. It is found commonly throughout the damp portions of the caves, under stones or bits of wood, sometimes wandering in the open. Al-

though it is totally blind it moves very rapidly, picking its way about unhesitatingly, probably by means of its long antennae. Some collectors have reported taking this species in the water but this is probably not often possible.

The other species, *Machilis cavernicola* Tellkampf, is rather rare. It has three caudal filaments and on its abdomen are peculiar little appendages, a pair on each segment supposed to be rudimentary legs. No modern insects have abdominal legs, but it is thought that the remote ancestors of insects did. This belief is supported by such evidence as the abdominal appendages of *Machilis*, and the appendages of each segment in such nearly related groups as the centipedes and crustaceans. In fact when first discovered, *Machilis cavernicola* was decribed as a crustacean, the abdominal appendages and its superficial resemblance to an amphipod misleading its finder.

SNAILS: Mollusca

Almost every collector has noticed snails in the Kentucky caves, generally giving them little attention because of the assumption that they had merely strayed in. Dead shells have been found more often than living snails, which perhaps partially accounts for the lack of interest in them. It seems probable, however, that snails of several species live and multiply in the caves.

One very small species, *Carychium stygium* Call, has been found only in the caves of this region. It has been called the only true cave mollusk of America but it is probable that it could be found outside of the caves if a search was made in cool, sheltered, continually moist places. It is true that it has the appearance of a cave animal, being white and small, about 1.85 mm. in length, but so have the other members of this genus and they are not confined to caves.

These slender high-coiled spiral shells are rather abundant in certain places in Mammoth Cave, Buzzard Cave, and White's Cave. In Mammoth Cave they were seen on the older deposits of silt about the Dead Sea and among the masses of fungus covering the rotting wood near the Mammoth Dome.

Polygyra appressa Say, a rather low shell with a diameter of about 15 mm., probably a common species in this region,

was found in five caves—Dixon, White's, Great Onyx, Mammoth Onyx, and Mammoth Cave. The largest number came from White's Cave. This snail was never found where it was impossible for it to have wandered into the caves. While they

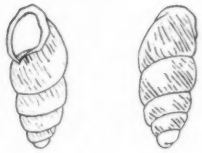


Fig. 89.—Cave Snail, *Carychium stygium*, a small white, spiral shell scarcely 2 mm. in length, found only in the caves.

were found at the inner ends of Mammoth Onyx and Dixon Caves and in Mammoth Cave at the Violet City, three miles from the entrance, it is still possible that they had recently entered from the surface since tree roots are to be seen in the walls and ceiling at all these locations.

Another snail, *Zonitoides arboreus* Say, found outside commonly under bark and leaves, was collected in numbers on and under rotting lumber about the Dead Sea. It is said to be considered a chance visitor, and since various sizes from so here in Mammoth Cave, several snails often found on the same bit of wood. It was too far from any known entrance to be considered a chance visitor, and since various sizes from quite small to the maximum, 5 mm., were found, it is probable that it was breeding in the cave, subsisting on the fungi so common on the decaying wood.

Another species of snail has been found several times in Mammoth Cave. This is *Polygyra hirsuta* Say, a brownish shell about 9 mm. in diameter and about half as high. One specimen was collected near the Dead Sea, and four other specimens from Mammoth Cave are in the National Museum. The exact locations from which these came are unknown but two of them are said to have been collected five miles back in the cave.

In White's Cave still another species of snail, *Zonitoides limatulus* Ward, was found rather common throughout the cave, on the walls, ceilings, floors, and on the rotting wood. Various sizes were seen but it is possible that all had strayed

in, since White's Cave is not very long. However, there is little reason why snails should not live and multiply in such a cave.

CRAYFISH, etc.: CRUSTACEA

Crustaceans are rather well represented in the caves. In addition to the conspicuous and well-known blind crayfish, there are four other regular inhabitants and several species of minute crustaceans that are found in the cave occasionally.

The blind crayfish, *Cambarus pellucidus* Tellkampf, is still rather abundant in the larger underground streams and pools. It is one of the few conspicuous forms of cave life and is frequently seen by the parties of visitors as they walk along the

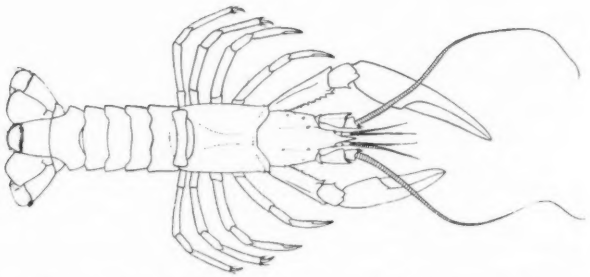


Fig. 90.—Blind Crayfish, *Cambarus pellucidus*, two or three inches long, colorless, and transparent are often seen in the cave waters.

board walks that parallel the shallow parts of the River Styx. Its white body stands out against the dark background of mud very plainly in the light of the gasoline lanterns used by the guides. Usually it is observed at rest but occasionally it is seen walking along as if it knew where it was going. They seem to lack entirely the inclination so characteristic of aboveground species to retreat under rocks and planks. They pay no attention to such shelters either when undisturbed or when frightened. When merely suspicious of danger they walk slowly towards deeper water, but if startled they swim blindly backward just as any crayfish does.

As the name *pellucidus* suggests, this animal is colorless and to some extent transparent. In shape it does not differ

conspicuously from other crayfish, being more slender, with longer and more delicate appendages. The average specimen is between two and three inches long.

Investigators say that these crayfish have lost both their sight and hearing. They are not only blind but have practically lost their eyes, the external part being reduced to the merest rudiment, and the optic nerve, while still present, is only weakly developed. Examination of the remnant of an eye leaves no doubt about their blindness but it is difficult to be certain of the loss of hearing since no crayfish has a well-defined ear. Experiments indicate, however, that this cave species is unaware of noises or anything but large disturbances such as would cause movement of the water. Slight disturbances are unnoticed and it is possible to touch them before they seem aware of the presence of danger.

Just what is eaten by these creatures is not well known. When in captivity they are indifferent to most food and refuse almost everything except the yellow of hard-boiled eggs. The only things they seem to relish are live isopods, *Caecidotea*, small flat crustaceans found in most of the cave waters. It is probable that these form its chief food supply under natural conditions.

Little is known of the breeding habits of this species. The eggs are supposed to be laid during the winter and are carried about attached to the appendages on the abdomen of the female until they hatch.

In addition to this species of crayfish there is another that regularly inhabits Mammoth Cave but which a casual observer would call a visitor rather than a regular inhabitant. Careful examination shows that while it has well-developed eyes they are smaller than those of its near relatives outside, its antennae are longer and it tends to be more spiny. These characters are apparently results of subterranean life. This crayfish, *Cambarus bartoni tenebrosus*, has been found to be a subspecies peculiar to the Mammoth Cave region. The stock, *Cambarus bartoni*, from which it developed and which it still closely resembles, is found above ground in springs and cool streams in the cave region and elsewhere.

In the cave the eyed form is found in about equal numbers

with the blind form but it may be distinguished at a glance by the presence of eyes and a normal amount of coloring. It grows larger and at any size is much stronger than its pale relative, which it is said to kill and eat on occasion.

Palaemonies ganteri is the name given one of the most spirit-like of all of Mammoth Cave's ghostly inhabitants. This blind inch-long, shrimp-like crustacean is all but transparent and when in the water is almost invisible. One opaque spot in the anterior part of its body is all that can be seen. Usually these creatures remain at the bottom, resting or moving slowly. When disturbed they leave the bottom and swim in a deliberate and steady fashion up near the surface, where they can be easily caught. If not disturbed again they soon sink to the bottom.

So inconspicuous are they that they escaped discovery by the early collectors. They were discovered first in 1901 by W. P. Hay and have been collected only once since (1929). They have been found in Roaring River twice, and once in a pool left by receding high water near the Dead Sea. They are probably present in most of the quiet waters of the cave.

In the smaller streams and springs in the caves several species of smaller crustaceans are common. Probably they are abundant in the larger bodies of water too, but they are not so conspicuous. They are supposed to be the chief article of food for the crayfish and blind fishes. Just what they themselves eat is unknown.

Amphipods, *Crangonyx vitreus* ?, laterally compressed, small, white crustaceans, were found in the small pools and streams in several caves. These rarely exceed a quarter of an inch in length and are blind, being without even rudimentary eyes. They are usually found resting or crawling along on the bottom. They are said to scoop furrows in the mud as they move along. When disturbed they swim briskly up from the bottom but soon sink back down and creep swiftly along, falling over to one side and then to the other, maintaining their balance with difficulty due to their flattened body and high arched back. In spite of their awkward movements they are good climbers, sometimes leaving the quiet waters and crawl-

ing up steep rocks over which a thin film of water passes. They were found frequently in isolated pools, sometimes on top of large stalagmites up the side of which they must have climbed to introduce themselves into the elevated basin.

Another amphipod, *Eucrangonyx gracilis*, somewhat larger, was found abundant in a small cave several miles north of Mammoth Cave. This species is not restricted to caves but has a wide range in surface water. When collected it was in company with an isopod, *Caecidotea stygia*, which is found in Mammoth Cave associated there with the amphipods, *Crangonyx vitreus*.

The cave isopods are also white and blind, but are somewhat larger than the amphipods, sometimes reaching a length of one-half an inch. Their body is flattened and narrow, their legs short and weak. A slow creep is their normal gait and even when disturbed they are unable to attain the activity displayed by the amphipods. They were often found under rocks and bits of planks but were as often out in the open.

The nearest relatives of this species are deep-water creatures, mostly marine. One species is found in the deep water of Lake Michigan.

Tiny, almost microscopic crustaceans have been found frequently in Mammoth Cave but little is known about them. Two species have been identified, one, *Cauloxenus stygius* Cope, living attached to the mouth of the blind fish, deriving its sustenance from juices and bits of food crushed by the jaws of the fish; the other, *Canthocamptus cavernarum*, a free-living form found in springs that probably receive water more or less directly from the surface, thus making it possible for this minute creature to be introduced from surface waters. Many small unidentified crustaceans were observed in July, 1929, in a pool near the Dead Sea. This water was left by subsiding floods and disappeared entirely shortly after first noted. It is not improbable that these crustaceans were brought in with the flood waters and were concentrated in the remaining pools as the water receded. Special study of the minute crustaceans outside of the caves as well as inside will be necessary in order to determine the status of such forms as these.

WORMS

All three types of worms have been found in Mammoth Cave. The Nematodes (round worms) have a representative as a parasite living in the larvae of one of the cave beetles, *Adelops hirtus*. *Dendrocoelum percaecum* represents the flat worms, and the earthworms (*Lumbricus* ? sp.) represent the Annelids or segmented worms.

The flat worm, *Dendrocoelum percaecum* Packard, is white and blind, about one-fourth of an inch long and one-sixteenth wide. It is abundant in quiet pools, on the bottom or on the under surface of the surface film, moving slowly along with no perceptible effort. Its only reaction to disturbances seems to be contraction and cessation of all movements. It was abundant in Richardson's Spring, where most of the visitors in the cave are given a drink. Since the worms are so frequently at the surface and can not avoid being dipped up it is interesting to wonder how many have been swallowed by the unsuspecting tourist.

Earthworms have been found in many of the moist parts of the cave, sometimes in the earth but most often in almost completely decayed wood. They were always small, those in the wood rarely exceeding an inch in length. These were frequently surprised resting with half their length in the wood, the other half lying outside. Specimens of *Helodrilus foetidus* twice as long were found in some very peculiar mud in Minervas Dome, distant from both the cave streams and from the surface. The smaller *Helodrilus tenuis* were found near the Dead Sea. If these are not regular cave inhabitants they must have come in through one of the nearby domes supposed to be connected with the surface. Other very small worms, apparently young earthworms, were taken in other parts of Mammoth Cave and at the inner end of Dixon Cave. These were so small that it is difficult to believe that they had travelled all the way from near the earth's surface. It seems probable that earthworms breed in the caves.

The segmented worms have another representative in the cave; a species of small white discodrilid worm, *Cambarincola philadelphica*, was found on the eyed crayfish in the cave streams. It was formerly classed as a leech but is separated

now. It has a sucker only at one end. They were noticed in large numbers attached to the soft regions at the joints of the crayfish's appendages particularly close to the body. Apparently similar worms were found on the crayfish in a small surface stream known to drain into the cave, so it is possible that the population in the cave might be constantly renewed from the breeding of those outside, the young being carried in with the water.

Some very small worms, probably Oligochoeta, were found in the silt deposited by overflow or backwater from the main cave streams near the Dead Sea. This silt was thickly dotted with what was apparently the casting of some minute burrowing worm. Careful examination of the mud produced only two or three of these tiny worms.

Very little time has been given to the study of the one-celled animals (Protozoa) in the cave. The few species that have been found in the waters of Mammoth Cave may be able to exist there but it is more probable that they are not strictly cave forms but are also found outside and are repeatedly introduced by water draining in from the surface.

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